An Analysis of the Impact of Decision Support Systems on the Performance of Upstream Commodity Chains

Thesis submitted in accordance with the requirements of the University of Liverpool for the degree of Doctor in Philosophy

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October 2017

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List of Abbreviations

ACSA	American Cotton Shippers Association
AML	Anti-money laundering
AII	Apparel import intermediary
B2B	Back to back
DSS	Decision Support Systems
ERP	Enterprise Resource Planning
ETA	Estimated time of arrival
ETS	Estimated time of shipment
FDI	Foreign direct investment
FOB	Free on board
GCC/GVC	Global Commodity Chain/ Global Value Chain
ICA	International Cotton Association
ICAC	International Cotton Advisory Committee
ICC	International Chamber of Commerce
ICT	Information Communication Technologies
IFC	International Finance Corporation
Incoterm	Trade terms published by the International Chamber of Commerce (ICC) that are commonly used in both international and domestic trade contracts
IRSG	International Rubber Study group
IT	Information technology
KPI	Key Performance Indicators
KYC	Know your customer
LC	Letter of Credit
M2M	Mark to Market
NAICS	North American Industry Classification System
SSCM	Sustainable Supply Chain Management
SHFE	Shanghai Future Exchange
SICOM	Singapore Commodity Exchange
TOCOM	Tokyo Commodity Exchange
TPL	Third Party Logistics
WTO	World Trade Organisation

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February/October 2017

Acknowledgements

First of all, I would like to express my gratitude to Professor Andrew Lyons for his guidance, support and encouragement throughout my research project and to Dr Iain Reid for support and advice during my studies. Your expertise and knowledge helped me shape my ideas and complete this research.

Special thanks are dedicated to the research participants and organisations that allowed open access to their information and staff, to Richard Williamson and Gary Williamson for expert industry advice and support throughout the study.

Beside from the academic support, I would like to thank my parents who motivated me to peruse this degree and have been my inspiration, my sister and brother in law for their support and encouragement. Finally, I would like to thank Philip for his unconditional support and patience allowing me to achieve my targets over the last four years of this PhD journey.

Abstract

The aim of this research is to evaluate the role and application of Decision Support Systems (DSS) adopted to improve the decision-making capability and visibility of the operations of intermediary trading organisations in upstream commodity supply chains. This research investigates the nature and source of specific challenges associated with upstream commodity supply chains that affect supply chain performance, namely, supply chain governance, access to finance, risk management and operational efficiency.

Upstream commodity markets are characterised by high price volatility and low unit value, high risk and lack of visibility. Upstream supply chains are highly complex involving multiple parties, cross-border transactions, information asymmetry and a lack of standardised rules and regulations (Ahumada, 2009). Intermediary commodity trading companies participate as mediators between the supply and demand of commodities worldwide and facilitate the transaction of goods between distant countries which allows them to adopt a key position in managing critical supply chain information and material flows (de Haan et al., 2003). Hence, the performance of intermediaries within the upstream supply chains have great impact on the supply chain overall.

Academic literature on DSS, upstream supply chains and intermediation have been reviewed in order to establish a reliable and contextual knowledge base. The relational view provides a theoretical grounding for the work.

In order to achieve the research objectives, qualitative multiple case study research was undertaken. The case studies were designed to analyse the changes in the case study company processes and operations before and after the implementation of the DSS, using cross-functional process maps. Three case studies with intermediary trading companies in rubber, coffee and cotton supply chains were undertaken. The research found a positive relationship between DSS adoption and business performance. The findings also reveal a significant mediating effect of DSS on supply chain performance. A triangulation research approach was chosen between collected qualitative data, observation and reviewed literature. Based on this finding and conceptual model, the study has contributed to body of knowledge concerning upstream supply chain practice.

1 Chapter 1 Introduction

This first chapter provides an introduction to the thesis by way of introducing some of the concepts, core literature and definitions that formed the basis for this research. First, the background to the research is provided, then the significance of the research is presented followed by a justification of the research questions. An overview of the research methodology and thesis structure are also provided.

1.1 Research Background

Upstream commodity markets are characterised by high price volatility and low unit value, high risk and lack of visibility (Banker et al., 2011; Anderson, 2014). Upstream supply chains are highly complex involving multiple parties, cross-border transactions, information asymmetry and a lack of standardised rules and regulations (Ahumada, 2009; Bode and Wagner, 2015) but have a significant impact on downstream manufacturing and distribution (Bair, 2009). The global trade value decline in 2015 has been mainly attributed to the fall in the prices of primary commodities. Since January 2016, the prices for primary commodities have dropped more than 50% on average including a 20% decrease for food and beverages, 30% on metals and 65% on energy (ICC Report, 2016).

Upstream commodity supply chains provide a unique operating environment where commodity trading companies participate as mediators between the supply and demand of commodities worldwide and facilitate the transaction of goods between distant countries which allows them to adopt a key position in managing critical supply chain information and material flows (de Haan et al., 2003), but at the same time taking on large financial and operational risks (Pirrong, 2015). Commodity trading companies are described as supply chain intermediaries who coordinate and arbitrate transactions between a group of suppliers and customers in the supply chains (Wu, 2004). This research is concerned with the operations of the commodity trading companies which buy and sell physical goods and take the title of goods. In upstream supply chains, intermediaries are designated to reduce transaction costs for their customers (Pirrong, 2015) and as a result, their operational and financial performance can have a significant impact on the total chain. The globalisation trends lead to widespread worldwide sourcing facilitated by intermediary organisations drive the need for improved understanding of the determinants of intermediary trade performance (Adida et al., 2015).

Additionally, within the current economic and social climate, commodity trading companies' operations and decisions are scrutinised by supply chain governing bodies as well as the public in regards to responsible sourcing and fair pricing, meaning that trading organisations are held accountable for sourcing practices to consumers (Sodhi and Tang, 2013). It is important to mention that some of the key issues that define upstream commodity supply chains are

factors such as the quality of crops or resources, safety (i.e food safety), weather and region-related variability (Ahumada, 2009), and market uncertainty (Hollis, 2011). This research investigates the nature and source of the challenges associated with upstream commodity supply chains that affect its performance.

Upstream commodity supply chains operations require processing of large volumes of data pertaining to product quality, locations, prices and export restrictions (Lapide, 2015). Information systems have been widely used in supply chains to help companies manage information flows in their day-to-day operations (Hendricks et al., 2007; Argyropoulou et al., 2015). Some of the most widely used information systems include ERP systems (Chou et al., 2005; Hakkinen and Hilmola, 2008; Lecic and Kupusinac, 2013), Decision Support Systems (DSS) (Cai et al, 2009) and other supply chain management systems (Hsu et al., 2009). This research is focused on the role of DSS in the operations of intermediary commodity trading companies in upstream commodity supply chains. DSS are of particular interest because they are often used to provide best, most appropriate or optimum action (Power, 2002), but even more importantly, DSS should provide decision makers with accurate and appropriate information to allow them make judgements about the outcomes of their actions on the supply chain (Hilletofth et al., 2016) which is extremely important in the context of upstream supply chains.

The relationships between supply chain partners have been recognised to have a significant impact on performance (Carr and Pearson, 1999; Gunasekaran and Kobu, 2007; Piotrowicz and Cuthbertson, 2015). Research has also shown the specific importance of relationships such as trust and power in upstream, commodity supply chains (O'Keeffe, 1998; Oxborrow and Brindley, 2014; Pirrong, 2014). Research has previously examined customer and supplier relationship management by intermediary trading companies (Fung, 2007). We are extending that view to see how DSS can further facilitate managing relationships and making effective decisions by applying relational theory in this research. Relational theory provides a framework for performance improvement via the examination of collaborative practices between partners.

Firstly, this research investigates the concepts and definitions of DSS and reviews the nature of upstream commodity supply chain challenges via an extensive literature review. Secondly,

the processes and operations of commodity trading companies are explored by collecting observational and interview data. Thirdly, the analysis of the impact of DSS on intermediary companies' operations and processes is provided. Lastly, the impact of these changes on supply chain performance is reviewed.

1.2 Significance of Research

Intermediary organisations take on the responsibility to ensure continuous supply and flexibility for their customers by effectively managing the supply chain, establishing relationships with stakeholders and using extensive knowledge about the supply chains and products that are traded. The need to better understand the particular roles and operations of commodity trading companies and their impact on upstream supply chain performance has been identified and recognised, benefitting upstream supply chains (i.e. 'middle men') (Adebanjo, 2009; Belavina, 2010; Amegashi-Duvon, 2014; Arya et al., 2015; Qu et al., 2015). Whist the majority of upstream supply chains research has been concentrated on operational optimisation and particularly inventory reduction (Worthen, 2002; Secomandi, 2010; Tanweer et al., 2014), supply chain integration and cooperation (Prajogo and Olhager, 2012; Williams, 2013). Some of the literature focused on food quality and traceability issues (Fredriksson and Liljestrand, 2015), sustainability and ethical issues (Luzzini et al., 2015, Lemieux et al., 2012; Larsen et al., 2012; Eswarlal, 2014) as well as historical and geo-political issues of capitalism, power, contract rules and regulations (Bair, 2012; Quark, 2003; Gibbon, 2014).

Furthermore, the negative perceptions of the intermediaries in the upstream supply chains have been acknowledged (Quark, 2011, 2013). The activities of global intermediaries in developing countries have been under a lot of scrutiny due to sustainability and fair pricing to farmers as well as claims of manipulations to exchange markets (Quark, 2011, 2013; Lichtenstein, 2012; Etienne et al., 2014; Gibbon, 2014). The key theme is to identify and understand the main issues related to the operations and complex processes in the upstream supply chains and how intermediaries using DSS can improve decision making and visibility, enabling improved performance throughout the supply chain and understanding of their role in the supply chain.

The purpose of this research is to better understand how decision support systems in upstream, commodity supply chains can manage risk, provide improved business and supply chain performance through enhanced decision-making based on appropriate data access, and enhanced operational and inter-organisational activity visibility.

In this research, a relevant set of theoretical frameworks and perspectives have been reviewed including the Supply Chain Framework (du Toit, 2014) and the Global Value Chain Framework (Sturgeon, 2009; Gereffi, 2014), which was used to allow for better understanding of the challenges and governance structures within the field. Operations management theories were reviewed including the Resource Based View (Bharadwaj, 2000; Subriadi et al., 2013; Sodhi, 2014) and Dependence Theory, Agency Theory and Transaction Costs Theory (Walker et al., 2015). The Relational theory was adopted as an overarching theory to capture the many complex, structural and behavioural aspects of supply chain networks (Dyer, 1998). The relational challenges found in supply chains that involve intermediaries include differences in understanding, information asymmetry, a lack of communicated strategies and policies which result in conflicting interests and cause behavioural uncertainty (Paché 1998 in Sandberg, 2017). Using a relational lens offers significant benefits to understand, design and manage upstream supply chains and such aspects as collaborations, coordination, communication and trust.

1.3 Research Questions

The focus of this research is on the impact of DSS on intermediary trader and supply chain performance. The following research questions were developed:

> **RQ1**. What are the core, performance influencing challenges of upstream commodity supply chains and how can these challenges be addressed or exacerbated by the actions of intermediary traders?

> **RQ2**. How can DSS used by intermediary, commodity trading companies help them make decisions that are pivotal to their performance and the performance of the supply chain?

1.4 Methodological Approach

This research uses qualitative case studies to examine the impact of DSS on upstream supply chains and intermediary commodity trading companies, and to evaluate the performance changes. Primary data was gathered from three case studies by participant observations and qualitative semi-structured interviews and secondary data collected by Internet background research and document analysis. Both corporate management and operational managers have been interviewed to gain insights from executive and operational levels. By concentrating on the intermediary trading companies of primary commodities it was possible to ensure a focused analysis of the research questions. The information that was gathered from case studies included:

- Operational activities of the commodity trading companies that were further transformed into cross-functional business process maps for different types of commodities.
- The main decision points of the processes associated with those activities
- The means by which such decisions were related to operational and strategic performance.
- An investigation of how company processes have been affected by the use of information systems.

International peer reviewed academic journals have been used for the literature review using key words: upstream/commodity supply chains, commodity markets, intermediary trading, import/export intermediation as well as combination of those key words with performance, DSS, governance, risk management and trade finance. Web based search engines used for this purpose – Science Direct, Ethos, Emerald, Google Scholar and Discover. Due to lack of academic literature which specifically concerns operations and design of supply chains with intermediary trading organisations, additional sources of information used including periodic magazines, industry journals, conference papers and market reports. The literature used in this research published between 1980s and 2017 with majority of literature published after 2010. The core academic journals included Supply Chain Management Review, Decision Support Systems, European Journal of Operational Research, International Journal of Production Economics and Journal of Operations management (see Appendix 2 and 3).

1.5 Structure of Thesis

The thesis is organised into six chapters. Chapter One introduces the research and provides the research context. Chapter Two covers the literature review relating to the research topic and comprises of three main sections. The first section discusses the DSS and their application in supply chain management. Secondly, subsection on upstream supply chain management literature defines primary commodity supply chains and provides details on three commodities used in this research. It also covers intermediary trade and descriptions of the supply chain challenges of the upstream supply chain operations. The third section focuses on the performance metrics used in supply chains. This section also discusses the theoretic lens that was applied in this study and provides a review of the relational theory Chapter Three details the research methodology, outlining the procedures followed during this research, including philosophical considerations, research design selection and data collection and analysis methods. Chapter Four summarises the research findings. The chapter relies on rich primary data collected by the researcher. It reviews the organisation processes, details information management architecture changes and outlines the changes undertaken due to information management transformation. Chapter Five provides a cross-case analysis of the findings. Chapter Six presents the discussion of the research findings in relation to the literature reviewed. Chapter Seven provides conclusions for the research, the contributions to knowledge and practice, and prospects for the future research.

2 Chapter 2 Literature Review

This chapter provides a literature review on three main fields of knowledge used in this research. Decision support systems in supply chains are discussed and defined leading to the introduction of decision support modelling features used in intermediary trade in upstream supply chains. Upstream supply chains are then further defined - commodities, participants and challenges of these supply chains are detailed and the conceptualisation of the intermediary trade of primary commodities is also presented. Specific attention is given to the relationships of the upstream commodity supply chains to highlight the complexity of the field. Performance measurement in supply chains is reviewed from established frameworks (SCOR, Balanced Scorecard) to the industry specific approaches (performance matrices used in agricultural supply chains). The overarching disciplines of operations management and the theoretic lens in this research concerning relational theory is reviewed. This chapter helps researchers to set research boundaries and answer research questions.

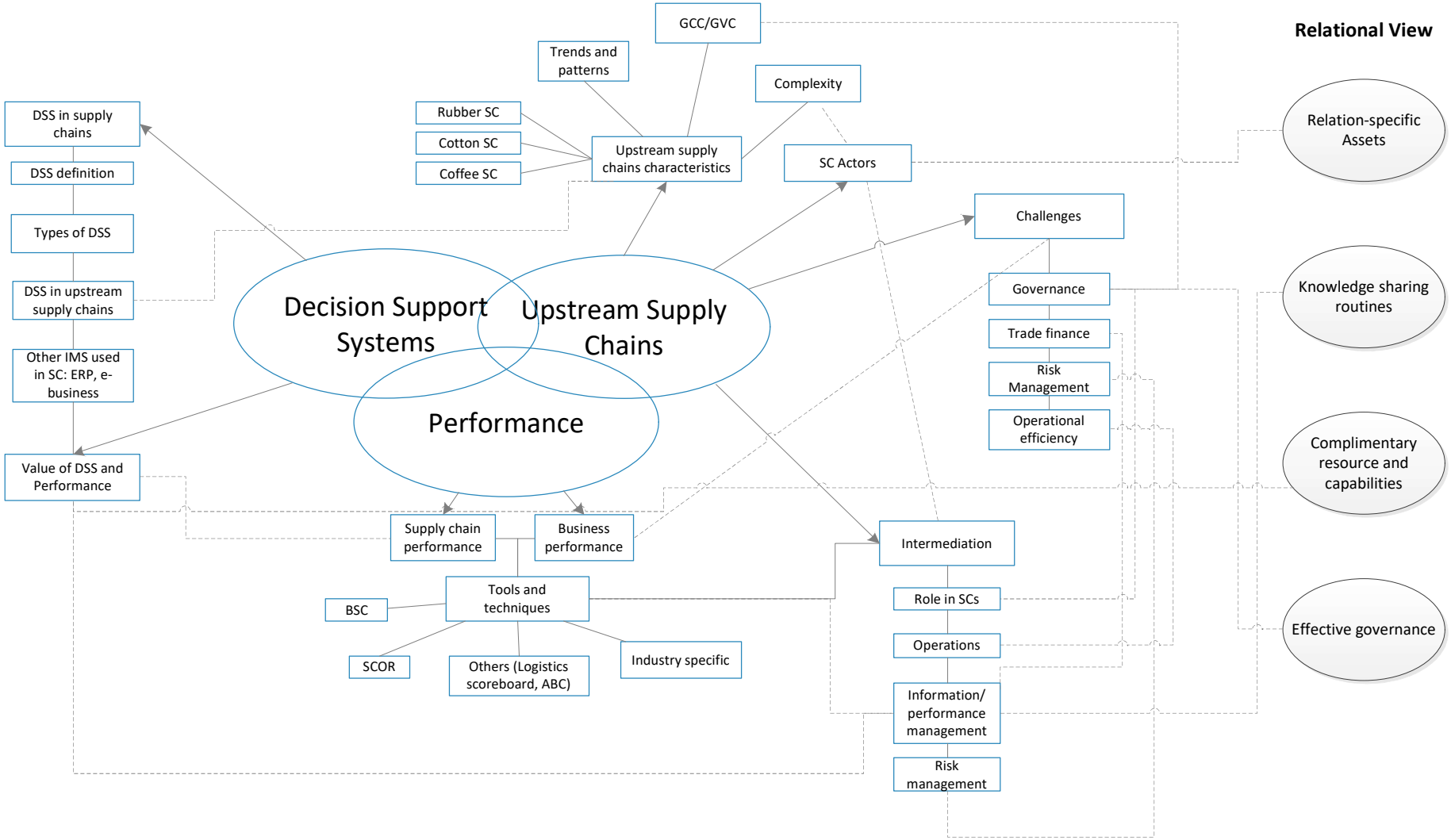

Figure 2.1 Literature Review Approach

2.1 Decision Support Systems

This section aims to provide a comprehensive view of the decision support systems (DSS), origins and definitions as well as types of DSS. Research into the application of DSS in upstream supply chains and operations management is presented. A designated subchapter reviews the value assessment of DSS and the impact of information systems on supply chain performance. DSS are also analysed in comparison to other information systems used in the supply chains such as ERP.

2.1.1 Origins and Definitions of DSS

Decision support systems (DSS) have been referred to as computer-based solutions for complex problem solving and decision-making (Shim et al., 2002). Gorry and Scott Morton (1971) describe that decision problems can be 'structured', 'semi-structured' and 'unstructured'. Shim et al. (2002) provides another classification for decision problems including routine, repetitive, or novel. Typically, the DSS decision-making process includes: problem recognition, problem definition, alternative generation, model development, alternative analysis, choice and implementation (see Fig. 2.2). It was suggested that DSS deal with a problem where at least some stage is semi-structured or un-structured (Shim et al., 2002). A computer system could be developed to manage the structured part of a DSS problem, but the decision maker's judgement is supposed to carry out the unstructured part, creating a human-machine problem-solving system (Shim et al., 2002). The focus of decision support systems is an ability to handle much "softer" information and address broader concerns than mathematical models and knowledge-based systems. The other description highlights the use of various resources and data in DSS: "DSS is an interactive computer-based system or subsystem intended to help decision-makers use communications technologies, data, documents, knowledge and/or models to identify and solve problems, complete decision process tasks, and make decisions" (Power et al., 2011).

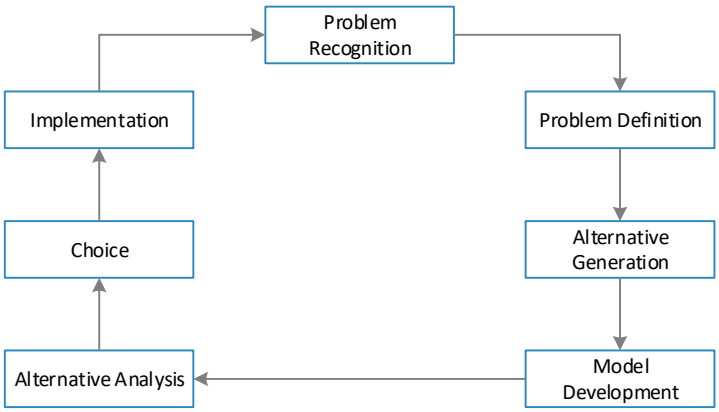

Figure 2.2 The DSS Decision Making Process (Shim et al., 2002)

As a discipline, DSS grew from two areas of research – the theoretical studies of organizational decision-making and technical work at MIT University (Shim et al., 2002). From an academic perspective, the DSS field is an expansion of the information systems discipline (Whinston, 1996 in Power, 2011). Original DSS projects focused on tasks like production planning and projections, operations monitoring, or observing hostile activities or national security activities (Power et al., 2011). One of the evolutionary steps in the development of DSS was the use of team decision-making for virtual team DSS (Shim et al., 2002). Group support systems (GSS) use a combination of communication and DSS techniques to facilitate working in groups. Other varieties of DSS have evolved through time: Negotiation Support Systems (NSS) used for negotiations between groups; Intelligent Support Systems (IDSS) using artificial intelligence techniques; Knowledge Management-Based DSS aiding knowledge storage and retrieval; Data Warehousing (DW) providing large-scale data infrastructure and Enterprise Reporting and Analysis Systems used for reporting and queries (Arnott and Pervan, 2008). Moreover, modern DSS address the need for faster decision making in order to respond to changes occurring in real-time as well as allowing personalisation to the users' needs or preferences, allowing time saving by using intelligent methods and enabling organisational learning, linking to knowledge management systems (Hess et al., 2000; Phillips-Wren et al., 2011; Liu et al., 2013).

Practically, decision support systems are now widely used and are becoming almost invisible when supporting decisions of consumers, organisation managers, enterprises and inter-organisational systems such as supply chains. An example of the use of DSS functionality was

described by Lee (2004). The system produces expert knowledge from a number of people and gives optimal recommendations to an individual consumer using behavioural patterns collected from a history of transactions. This technology is particularly useful in cases where the customer does not have previous history or enough knowledge about specific goods. The system uses information from other users with similar behaviour patterns to make recommendations.

2.1.2 Types of DSS and Built Frameworks

There are different types of DSSs, including communications-driven DSS, data-driven DSS, document-driven DSS, knowledge-driven DSS and model-driven DSS (Power, 2002). Special attention in recent research was given to simulation-based DSS, which use simulation software to model and implement real systems (Hilletofth et al., 2016).

DSS is designed based on different data input, analysis requirements and decision-making processes of the company using this system.

1. Communication-driven DSS – facilitates Group DSS
2. Data-driven DSS – emphasizes access to and manipulation of a time-series of internal company data and sometimes external and real-time data. A simple file system accessed by query and retrieval tools provides the most elementary level of functionality (i.e. Executive Information Systems)
3. Documents-driven DSS – helping managers find documents to support their decision making
4. Knowledge-driven DSS – or Suggestion DSS (Alter, 1980 in Power, 2011)
5. Model-driven DSS – emphasizes access to and manipulation of financial, optimization or simulation models. They use limited data and parameters provided by decision makers to aid them in analysing a problem situation.

Traditionally, there are three basic capabilities in DSS: data management, model management and dialogue management (Shim, et al. 2002). These three capabilities refer to the abilities to manage data, design models to structure problems and formulate solutions, as well as create

an interface to enable queries, graphing and reporting functionalities in order to support decision-making process. Ayankoya et al. (2016) suggest that DSS require a data component, modelling component, knowledge component and user-interfacing component, highlighting the importance of knowledge management module within DSS. Knowledge management is a critical part of the DSS. Jain et al. (2009) claim that the knowledge management is inseparable from information technology and discuss the need for computer-based technologies to be based on clear considerations of knowledge management.

Decision support systems use data and models and provide interfaces for the user to interact with this system in "exploring the decision space, and may provide recommended courses of action through methods such as intelligence or knowledge systems" (p. 206, Philips-Wren et al., 2011). The DSS architecture is proposed to have a database of relevant decision data, knowledge base (i.e. production rules) and model base, which contains decision models and solution methods (see Fig. 2.3). Decision support systems are suggested to benefit from artificial intelligence methodologies, which can be used to generate forecasts of problem elements within the processing phase. DSS are dynamic in nature. Feedback loops between system outputs and the decision maker, from processing to inputs, ensure continuous interaction DSS (Phillips-Wren et al., 2011).

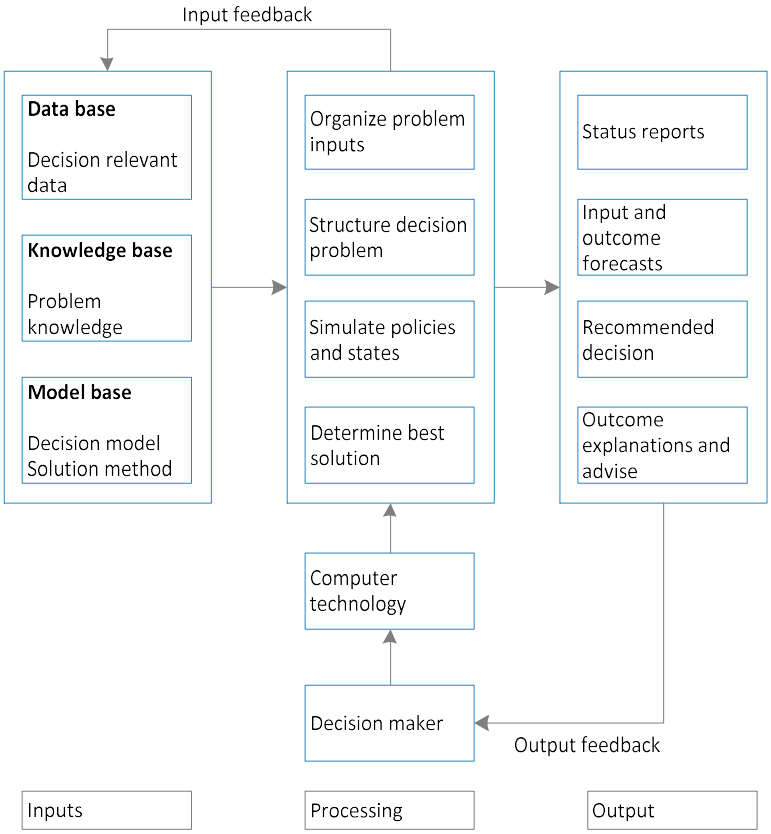

Figure 2.3 DSS Architecture (Phillips-Wren et al., 2009)

There is a number of modelling languages used for DSS. The languages are categorised base on user interface and required development environment into textual (Tx), code-oriented (Co) or visual (Vi) (Hernández et al., 2014a). Modelling languages are continually evolving and are mainly code-oriented and integrated techniques. One of examples of modelling languages is CIMOSA. The language provides a set of modelling constructs to clearly represent processes, resources, information flows and organisational structures. Derivation dimension allows multi-perspective modelling constructs that allow decomposition of the enterprise to drill into detailed tasks. CIMOSA allows to view the 'big picture' and detailed process levels. Generation dimension is concerned with life cycle mapping of processes, resources, information flows and organisational structures. Installation dimension is concerned with the level of what models and implemented solutions are general across the system or of primary concern of a task (Masood and Weston, 2013). Other standard modelling languages include UML, GRAI and IDEF (Hernández et al., 2014a).

2.1.3 DSS Applied in Supply Chain Management

Decision Support systems are becoming more widely used to help supply chains manage their operations better. The decision support systems in the supply chains should provide decision makers with appropriate and accurate information and the ability to predict the outcome of the decisions and their impact on the entire supply chain (Hilletofth et al., 2016). It has been recognised that "due to the complexity and uncertainty in supply chains, it is normally not possible or desirable to create fully automated decision systems that rapidly identify and execute optimal decisions" (p. 49, Kallestrup et al., 2014). However, research is lacking into real life implementation and case studies of DSS and simulation-based DSS (Hilletofth et al., 2016).

A variety of studies reviewing the use of DSS in supply chains have been found. Tan et al. (2012) developed a multi-criteria decision support system for B2B collaboration in supply chains; their system supports decision makers choosing the best options from ranked options, which can improve the speed and accuracy of decision making in a fast changing supply chain environment. Pinto et al. (2013) design a human-in-the-loop DSS to support managing risk of supplier delivery reliability in order to reduce delays. Hu and Sheng (2014) offer a DSS to manage public logistics service information and minimise the empty load ratios of vehicles. Hong and Lee (2013) describe DSS for procurement risk management and planning, supplier selection and order allocations for the operations involving stop market to allow the buyer to make decisions in existence of price and uncertainties. These examples show the significant development potential of decision support systems in supply chain management. It is recognised that the supply chains target developing comprehensive, shared, integrated information systems that encompass human and ecological dimensions during the next decade (Weichselbaum, 2012).

An example of DSS of particular interest and the field of commodity supply chains has been presented by Marimin et al. (2013) who explored optimisation strategies for natural rubber supply chain management based on rubber manufacturing practices in Indonesia. The scope is made on maintaining the efficient production process, while adhering to the high standards and at the same time reducing the environmental impact as much as possible. The proposed solution for the defined scope was the application of a specifically developed decision support

system. This tool is designed to improve supply chain management decision-making processes in a way that provides thorough data gathering and analysis, thereby employing highly efficient strategies. The analytical step is a substantial part of the entire system, for it requires consolidating data from different sources, accounting for all possible factors that may influence a natural rubber supply chain. This includes taking into account the needs of rubber farmers working on plantations, the overall agricultural industry trends, regulations and standards, consumer preferences and future industry prospects. Additional complexity within the natural rubber industry means communication between farms, mills, agents and other participants – direct and informal communication leads to further difficulties in strategic planning. The 'Agrogreenrubber' system developed by Marimin et al. (2013) is given as an example of the viable decision support system alternative for natural rubber sector supply chain management that incorporated economic and environmental aspects in order to manage and support productivity improvements (see Fig. 2.4). By providing a selection of models and decision alternatives for prospective consumer selection, strategy selection and company performance measurement, the system assisted decision makers in productivity improvements and allowed considerations for an environmental aspect.

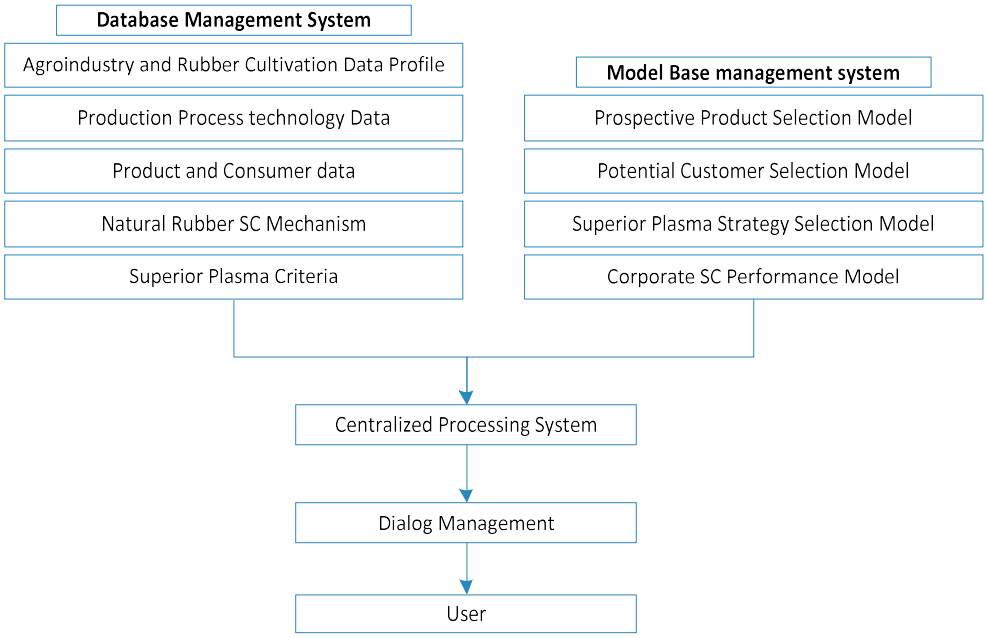

Figure 2.4 Natural Rubber DSS Configuration (Marimin et al., 2013)

The decision making environment tends to be more complicated and decentralised in supply chains requiring DSS to not only support traditional problem solving, but to also improve collaborative control and overall performance of the supply chain.

Koh et al. (2013) establish the need for DSS for carbon emissions accounting and management, as well as describing the design and development of SCEnAT – DSS for SC environmental analysis. This tool is designed to be used by collaborative networks of firms for informed decision-making in reducing carbon emissions at a supply chain level. Toka et al. (2016) also presented the DSS for carbon mapping of the supply chain to "allow businesses to establish a holistic understanding of their supply chain wide environmental hotspots and ensuring supply chain collaborative networks have a shared understanding of their emissions" (p. 21, Toka et al., 2016). Ayankoya et al. (2017) describe how DSS have been used for grain commodities trading to provide price predictions for various trading options. DSS in this case collects and integrates disparate datasets that deem to influence the price of commodities. The value of data visualisation within DSS "bridge the gap between analytics and the consumption of analysis" and help users to observe changes in patterns in large datasets (p. 11, Ayankoya et al., 2017). Other examples include García et al. (2013) who provided a DSS model for supplier selection for commodities procurement in order to optimise such selection and standardise supplier selection decisions. Luo et al. (2002) also introduced an intelligent multi-agent DSS applied in stock trading markets.

2.1.4 Value of DSS and Impact on Performance

Decision support systems cannot be easily evaluated by traditional cost-benefit analysis due to the qualitative nature of the benefits from using DSS, including examining a larger number of alternatives, idea generation, teamwork, enhanced learning and increased confidence in decisions made (Philips-Wren et al., 2011). The difficulty in defining general measures of decision quality is keyed in the difficulty of understanding human and organisational decision-making processes (Simon, 1960; 1987; Newell and Simon, 1972 in Phillips-Wren et al., 2011). It was suggested that DSS can be evaluated based on the origins of their purpose – the impact on decision making, which can be effect on the process of decision making or actual outcomes from those decisions (Philips-Wren et al., 2011). The models for assessment of technology for

support of decision making have been identified in the literature. First of all, it is suggested to consider the process of decision making itself. A rationalist approach sees decision making as a sequential series of steps (Pohl, 2008 in Philips-Wren et al., 2011) and Simon (1960 in Philips-Wren et al., 2011) provided a four step process of decision making – intelligence, design, choice and implementation. Secondly, DSS are assessed based on "what" characteristics leading to improved decision making. These characteristics can be: assisting managers at all levels, supporting interdependent decisions, being easy to use or others defined by the managers' performance objectives of DSS (Philips-Wren et al., 2011). The Value Analysis has been proposed as another appropriate for DSS. This method compares the benefits to the amount someone would pay to achieve those benefits without considering DSS to compare with the costs to adopt DSS (Keen, 1982 in Phillips and Wren, 2011). Phillips-Wren et al. (2011) concludes that assessment of DSS should include both the process (efficiency and outcomes) and effectiveness from decision making to an individual user. The framework for evaluation of DSS used by Phillips-Wren includes both process, outcome, technical and managerial considerations (see Fig. 2.5).

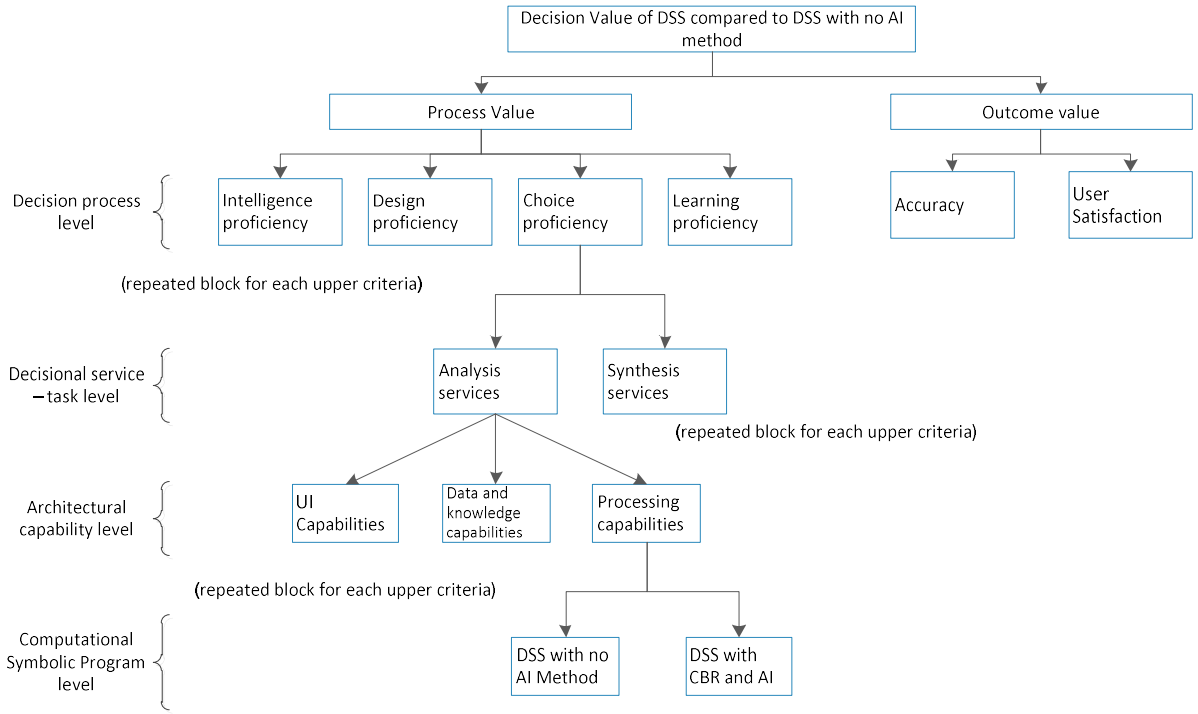

Figure 2.5 Evaluation model for DSS (Phillips-Wren et al., 2011)

The process enhancement from the use of DSS are emphasized: “Such information can be used to improve system support for decision making and to justify DSS expenditures by focusing attention on the value of process enhancements as well as outcome measures” (p. 216, Phillips-Wren, 2011).

Ben-Zvi (2012) explored the factors that enhance perceived effectiveness and the impact on performance of DSS from user involvement in the development of the system. The author mentions that many process variables such as attitudes, satisfaction and perceived usefulness may appear less important for organisations as well as harder to measure. The main performance measures for DSS look at whether an organisation’s design objectives or performance expectations are met (Kamis et al., 2008 in Ben-Zvi, 2012).

The empirical studies found the positive impact of DSS on supply chain performance. Borade and Sweeney (2015) showed empirical evidence that substantial economic benefits can be realised with algorithm-based DSS in a vendor-managed inventory supply chain, emphasizing the importance of collaboration and information sharing in supply chains.

The large body of knowledge about performance enhancing features is concentrated in information technology and information systems. The summary of performance-enhancing features and benefits is presented in the Table2.1. Collaboration in this research is defined from Bartlett et. al. (2007) and is explained to occur when “two or more companies share the responsibility of exchanging common planning, management, execution and performance measurement information” (Bartlett et. al., 2007). Coordination is referred to as firm’s ability to coordinate transaction-related activities with its member or partners (Bartlett et. al., 2007)

Table 2.1 Summary of identified benefits of IT and DSS in previous research

BENEFIT	DESCRIPTION	REFERENCES
INCREASED VISIBILITY	• Efficient information sharing • Improving timeliness, trustworthiness, and usability of data • Establishing the type of relationships between counterparties for effective execution of their functions	Mohr and Sohi (1995); Francis (2008)

	• Standardising processes and documentation	
IMPROVED DECISION MAKING	• The information, which is easily accessible by means of DSS, allows for better-informed and quicker decisions to be made • The companies use data analytics to inform supply and demand decisions to manage their business process • Information sharing which means capturing and disseminating relevant information at the right time to enable decision makers to plan and control operations in the supply chain • Decision synchronisation enabled - joint decision making in planning and operations while incentive alignment referred to the extent to which participants in the chain share costs, risks and benefits is assisted by IT	Simatupang and Sridharan (2005); Adebanjo, (2009); Caridi, et al., (2014)
COLLABORATION	• Information sharing, decision synchronisation, and incentive alignment • Partnering in supply chains if often viewed as source of competitive advantage by means of log-term strategic partnerships motivated by value-creation and mutual profitability or through short-term operational gains • The advance in information technology is a major driver for increased collaborative activities • Relationship performance in terms of achievement of mutual goals, problem solving, and procedural efficiency	Anthony (2002); Buxmann et al., 2004; Simatupang and Sridharan (2005); Bartlett et. al., (2007); Saldanha et al., (2013); Hernandez et al. (2014); Hollmann et al. (2015); Busse (2016)
COORDINATION	• Coordination in supply chains includes the management of materials, finances, workforce, and capital equipment from when an order is received to the processing of these orders. • Substituting information and knowledge for actual inventory, and promoting the creation of new coordination structures • Reduction in coordination and transaction costs and risks	Lewis and Talalayevsky, (2004); Wu et al. (2006); Kanda and Deshmukh 2008

2.1.5 Issues and Complexities of DSS Discipline

Arnott and Pervan (2008) proposed eight concerns for DSS discipline from the content analysis of DSS literature. First of all, the relevance of DSS research for practice is identified.

The information technology industry is fast evolving ahead of theory development, thus there is a need for greater exposure of academics to professional practice. Secondly, the major use of a positivist paradigm in DSS research and lack of interpretivist paradigms is observed. The DSS field is also criticised for the lack of references to the foundation theories in their research. The debate about the role of IT artefacts in the DSS research is highlighted. The funding from national agencies, by industry and universities of DSS research, is brought to attention as the fifth issue. The conservatism of DSS research agendas and low proportions of research about the latest types of DSS applications like Enterprise Reporting and Analysis are lacking. The seventh issue finds there to be a lack of DSS publications in high quality academic journals. And finally – discipline coherence is lacking, as the research comprises of reasonably isolated sub-fields (Arnott and Pervan, 2008).

Yuviler-Gavish and Naseraldin (2016) explore aspects of the ways that users utilize DSS. The goal is to test the role of prior experience when using decision support tools. Even though the research on the user's readiness to accept the assistance has been scarce, certain studies have been made, which demonstrate that specific factors, such as time pressure or lack of information, makes the probability of using the system recommendations, as well as overall reliance on the system, higher. However, these studies did not take into account how prior experience affects the need to accept decision support. The results did not confirm the hypothesis demonstrating that a group with prior experience of a task without decision support did not affect the level of decision support acceptance compared to the group that had both. Two groups (support group and mid-term support group in the second session) have shown a similar level of acceptance. Therefore, it has been shown that prior experience not utilising the decision aid is unnecessary. "Furthermore, having the experience can also delay the process of learning how to best utilize the decision aids" (p. 446, Yuviler-Gavish and Naseraldin, 2016).

According to Liu et al. (2009), the main challenges for DSS include new technology emergence, growing interconnection with other information systems (such as ERP system) and increasing complexity of decision making situations. They also study integrated decision support system (IDSS), which is upgraded from the traditional system and developing to be a more integrated and intelligent system.

2.1.6 Other Systems Used in Supply Chains

One of the best known and widely applied information technology is Enterprise Resource Planning. An ERP system is a management information system that integrates all of the business activities within an organisation, such as manufacturing, sales and distribution, procurement, human resources, accounting and finance (Ross et al., 2006). ERP systems stem from Material Requirements Planning (MRP) and Manufacturing Resource Planning (MRP - II) (Jacobs and Weston, 2006), which is ideally implemented to record, process, monitor and report all business transactions in the organisation, including material management, production planning, customer order management, and so on (Helo et al., 2005). According to Nah and Lau (2001), the most important characteristics are its capabilities of automating and integrating business processes, sharing common information and practices across the company. Handfield et al. (2009) also state that an ERP system is applied to standardise business processes and support decision-making in daily operations. The ERP system market is dominated by several large companies, such as SAP, Oracle. Kim et al. (2006) suggest that the large transnational companies tend to select SAP, Oracle, or other big vendors, which can improve the performance compared with other ERP systems or no ERP systems.

ERP systems have been criticised for rigid structure, processes, and broad focus. It is suggested that information systems should be tailored to the needs and operations of supply chains. For example, upstream supply chains require systems to support Supplier Relationship Management (SRM) and downstream with Customer Relationship Management (Grubic and Fan, 2010).

Shariat and Nwakanma (2011) compare ERP and DSS by outlining the key differences, as well as similarities. As the latter become more widely used, the possibility of their convergence in the future becomes more feasible. DSS and ERP are both software-based tools, but have different structure, the key purpose of ERP systems is keyed in the name of its predecessor MRP – material resource planning.

There have been certain problems trying to align the organisation strategic planning with ERP tools due to the specificity of how the application’s algorithm might be structured, which may not match supply chain management needs across various sectors. Certain gaps inherent to

ERP may be filled by DSS implementation but it too has limitations in how the data analytics and data warehousing is structured, which poses the risks of limited scalability.

The increasing complexity of supply chain networks exposes drawbacks in both systems. Although they both are evolving to offer more efficient tools, the necessity to converge DSS and ERP becomes more and more desirable. This would require knowledge exchange between the specialists working in the domain of either of these tools. Transaction specialists from the ERP and data warehousing specialists from the DSS should engage in closer collaboration to further converge the two systems and bring forth the more advanced combined solution for supply chain management.

2.2 Review of Upstream Commodity Supply Chains

In the second sub-chapter, the upstream supply chain is presented and the context of the study is outlined. This section reviews the research undertaken in upstream supply chains and provides examples of three commodity supply chains – rubber, coffee and cotton.

2.2.1 Upstream Commodity Supply Chain Definition

The definitions of "supply chain" are focused on the movement of materials forward till they reach final consumers who are also treated as part of the supply chain (Mentzer et al., 2001; Ellram and Zsidisin, 2002; Lambert, 2008). Supply chain management is essentially planning and coordinating the flow of goods, services and information along connected firms, which is targeting cost reduction, quality improvements and overall supply chain flexibility (Scannell et al., 2000). Effective supply chain management is associated with significant performance improvements (Cao et al., 2013; Seidmann et al., 2015). The terms "upstream" and "downstream" are commonly used in commodity supply chains to describe the company position in the supply chains. There is a lack of uniformity in defining upstream supply chains. The general understanding of these chains is related to input industries that are then fed into production or manufacturing of goods (Bode and Wagner, 2015). Other researchers refer to upstream as a production/manufacturing part of the supply chain (Ageron et al., 2013; Srivathsan et al., 2017). Downstream supply chains are understood to relate to retail and distribution of goods (Bode and Wagner, 2015). In this research, the upstream supply chain refers to companies located at the very beginning of the supply chain and occupied with resource extraction or farming. Downstream companies are occupied with processing and marketing as well as distribution of the goods to the final consumer. Upstream supply chains provide primary commodities to the supply chain and also represent the first-tier suppliers of long manufacturing chains. Additionally, "commodity" does not have common terminology in the literature, but tends to be used to refer to raw materials, which require further processing before consumption (Bair, 2005). In this research, any physical goods or raw materials that can be traded (i.e. in bulk) or products of primary economic activities (Watt,

2015) are considered as commodities, and commodity markets are markets where commodities are traded.

2.2.2 Classification of Commodities

Commodities are generally grouped as agricultural, energy and metals (see Table 2.2). Agribusiness is a term that is generally applied to various businesses involved in food production as well as other crops. Agri-food supply chains have some features that distinguish them from other supply chains including the nature of production represented in product variability, product perishability and bulkiness, and crucial need for food safety, consumer attitudes towards animal welfare and environmental impact (Aramyan, 2006). Generally, commodities differentiated by specific quality criteria defined by commodity grades and packaging. Some commodities can also be classed as non-codifiable due to high varieties between countries (ex. coffee).

Table 2.2 Tradable commodities on exchange markets (examples, see full table in Appendix 1)

COMMODITIES	GROUP	MAIN EXCHANGE	CURRENCY
CORN	Agriculture	CBOT/Euronext	USD ($)
SOYBEANS	Agriculture	CBOT	USD ($)
WHEAT	Agriculture	CBOT	USD ($)
PALM OIL	Agriculture	Bursa Malasia	Malasian Ringgit (RM)
COCOA	Soft	ICE	USD ($)
COFFEE	Soft	ICE	USD ($)
COTTON	Soft	ICE	USD ($)
SUGAR	Soft	ICE	USD ($)
LIVE CATTLE	Agriculture	Chicago Mercantile Exchange	USD ($)
RUBBER	Agriculture	Singapore Commodity Exchange	US cents
CRUDE OIL	Energy	NYMEX, ICE£	USD ($), GBP (£)
NATURAL GAS	Energy	NYMEX	USD ($)
GOLD	Metal	COMEX	USD ($)
ALUMINIUM	Metal	London Metal Exchange, NY Exchange	USD ($)

The commodities are traded on commodity exchange markets worldwide. The exchanges provide a regulatory mechanism for the valuation of commodities. Intermediary trading companies use market prices to get the value of the future contracts - marking physical position against the market prices to review the current value of goods (M2M). On the physical trade level, the market prices and price indices set at the market exchange level are used for price setting for long-term contracts, capacity, and cost decisions (Geman, 2012). It is important to note that the trade of commodities on futures markets rarely results in deliveries of physical goods and commonly used as a mechanism for managing risks of price changes (Watt, 2005). The risk management and commodity futures trade will be discussed in detail later in the chapter.

2.2.2.1 *Global Commodity Chains/Global Value Chains*

The Global Value Chain framework focuses on the importance of trade within the global networks of firms and transnational corporations. The framework is trying to understand trade processes and operations within GVCs identifying power and control issues in the supply chains. The trade relationships represent both challenges and opportunities for all the stakeholders involved, including governments, international organisations, buyers and suppliers (Gereffi, 2014). This framework has been chosen for review to highlight the globalised nature of the supply chains, show the importance of value adding activities such as marketing and branding, and highlight the complexities involved in the commodities turnaround.

Geographical fragmentation of production processes according to comparative advantages of locations became more developed because of technological progress, costs reduction, extended access to market and resources and trade policy reforms (De Backer and Miroudot, 2014). International fragmentation became a source of competitive advantage and increased efficiency. Various authors have shown interest in the subject matter looking at it from a global point of view. The idea of a commodity chain was first conceived in 1970 by Emmanuel Wallerstein who referred to it as “a network of labour and production processes whose result is a finished commodity” (Lichtenstein, 2012). This definition was adapted by Hopkins and

Wallerstein (1986) for commodity supply chains. Global Commodity Chain (GCC) was again defined by Gereffi and Korzeniewicz (1994) to be "a set of inter-organisational networks clustered around one commodity or product", which implies all the activities involved in designing, producing and marketing the product (Gereffi, 1999). In recent years, the term commodity chain has been replaced with value chain. Global Value Chain (GVC) is said to capture a wider range of products, some of which lack commodity features (Gibbon and Ponte, 2005). It is concerned with the links in the movement, and value-added activities of commodities from production to consumption: "Concept of Value Chain emphasizes the interconnected and sequential nature of economic activity in which each link adds value in the process" (Gibbon and Ponte, 2005). Moreover, a GCC/GVC framework was developed to explain geographical arrangements of the trade, production and consumption in the global economy (Gibbon and Ponte, 2005). The term 'chain' is used to mean the vertical relationship between buyers and suppliers as well as the movement of goods and services from producer to final consumer. This framework is generally concerned with the flow of physical goods, finances, knowledge and information shared between different participants (Gibbon and Ponte, 2005). Authors used it to analyse different supply chains: clothing (apparel) supply chains from East Asian countries to the United States by Gereffi (1999); Clancy (1988) used the framework in research dedicated to tourism; Schmitz (1999) analysed footwear; services were presented by Rabach and Kim (1994). Recently, the term 'global supply chain' emerged in several international academic journals and despite variations, generally refers to a "supply chain in the global context of today's business landscape" (p. 1432, Ibrahim et al., 2015).

In assessing the research on GCC/GVC, Bair (2005) further explains GCC as principally concerned with the issue of what benefits the exporters of developing countries and what they get from the participation in the commodity chains. The author also suggested that the research in GCC/GVC focused on middle level of sectoral logistics and micro level objective of industrial upgrading and concluded that more research is required to understand institutional and structural environments, in which commodity chains are embedded to provide an understanding of asymmetric dynamics in the development of different countries (Bair, 2005). GVC have been used to develop estimates of trade flows and derive data on the value added by each country in the value chain (De Backer and Miroudot, 2014). The framework

provides the mean to examine the position of countries within an international production network.

The stronger emphasis on the economic value added by each link of the supply chain shifted focus towards explicit structural elements of production, distribution and consumption in the supply chains, whilst the social and symbolic relationships between actors were less developed. The primary concern of the GVC framework is configuration of coordinated activities divided among firms of global geographical bases (Gibbon and Ponte, 2005). It deals with the aspects of inter-national trade, as well as all activities involved from production to consumption of commodities and also to the links between them (Raikes et. al., 2000). GVC has given meaning to 'globalisation' across a range of commodities products including textiles, clothing, coffee, cocoa, footwear, electronics, household furniture and much more. In this research, the framework is used to better understand the environment of the phenomenon under investigation and specifically governance structures within global value chains.

2.2.2.2 *GCC/GVC Framework*

The GVC framework is shaped around four dimensions. They are input-output structure, defined as the set of products and services connected in an array of value adding economic activities; geographical coverage highlighting the spatial distribution or concentration of enterprise in production and distribution networks; the governance structure that defines the authority and power relationship (Gereffi and Korzeniewicz, 1994); and the institutional structure through which the globalisation at each stage in the chain is framed by the national and international conditions (Gereffi, 1995 in Fagan, 2006). The governance structure of the GVC has gained much attention because of the concept of barriers to entry and chain co-ordination that emerged in the analytical framework. The theory of buyer-driven and producer-driven GVC governance structure also comes into play here (Ponte, 2002).

Input-Output Structure – the sets of input-output relationships constitute a value-added chain of products, services and resources networked across a range of industries, which results in the production and distribution of finished products to final consumers. With the

recent shift to vertical dis-integration, supply chains now involve the set of connections between previously vertically integrated firms and a set of intra- and inter-firm networking activities such as outsourcing and subcontracting (Fagan, 2006).

Institutional Structure – the institutional structure constitutes the government and non-governmental organisations(NGOs) who are interested in the regulation and deregulation of production, distribution and consumption at all levels such as local, national, supra-national and global (Fagan, 2006).

Geographical Coverage – Most commodity products are known to have very complex geographical footprints. The increasing attention to ethics of consumption in developed countries has given rise to the need to know the origin and 'shadow geographies' of consumer products. Shadow geographies can cut across many parts of the globe and this involves conditions of production, including environmental impacts, social justice and human rights issues (Fagan, 2006).

Governance Structure – this describes the authority and power relationship between firms and agents at each stage in the supply chain. The flow of resources and share of profit is also considered in this dimension. Gereffi and Korzeniewicz (1994) argue that governance structure for the networked GVCs can be identified as falling into two dominant types: producer-driven and buyer-driven. Producer-driven supply chains are the SCs with high technological and capital requirements where the producer tends to keep control of the major capital investment operations and encourage vertical integration. Buyer-driven supply chains are labour intensive sectors, where production functions are mainly outsourced. The key actors focus on branding, design and marketing. Moreover, different types of a lead firm define the supply chain, for instance, retailers and brand marketers tend to drive supply chains of fresh fruit and vegetables, coffee, cocoa and clothing, whilst transnational traders are more influential in the supply chains for cotton, fish, etc. (Gibbon & Ponte. 2005). In addition to that, Quark (2011) specifies this classification as an overall power structure, which, however, lacks the description of the relationships between specific participants of the supply chain.

The commodity supply chains used in this research falls under the category of buyer-driven supply chains, which means that the competition between the suppliers (commodity intermediary traders in this case) is high and it is essential for them to achieve a competitive advantage by means of cost reduction, efficiency improvements, and use of information systems. Understanding the governance structures of the supply chain will help uncover the power structure of this supply chain (Bair, 2005); and understanding of these power structures helps further comprehend the dynamics of the global industries and tools used for performance improvements.

2.2.3 Global Commodity Production and Trade Trends and Patterns

Many countries are relying on the import and export of primary commodities for income on the one hand and manufacturing of goods on the other hand. Trade in goods and services has fluctuated significantly over the past 20 years due to advances in information technology, the financial crises, the growing membership of the WTO, natural disasters, and geo-political tensions (WTO report, 2015). Some milestones in global trade development closely related to changes in trade and prices of primary commodities included China's accession to the WTO in 2001 leading to its economic rise and increase in economic trade. Chinese demand for natural resources drove prices for primary commodities up between 2002 and 2008. The financial crisis of 2008, triggered by the lending crisis in the US, started the global recession between 2008 and 2011 and led to a dramatic reduction of world exports by 19 per cent. Exports started recovering in 2010 with a 14 per cent growth rate. However, the prices on primary commodities hindered further improvement of economic conditions. Prices for oil increased in 2010 due to political instability in oil producing countries. Additionally, the European debt crisis in 2011 affected world trade growth. Since 2014, the world trade has been slowing down again due to geo-political tensions and further debt crises. The world merchandise trade growth averaged 1 per cent only between 2012 and 2014. At the same time, WTO statistics show the trade of services has been less volatile over the last 20 years showing greater resilience of services during macroeconomic turmoil.

The internalisation of production and manufacturing has led to an increasingly global spread of value chains. Between 1995 and 2011 most developed and developing countries significantly increased their participation in global value chains. Low trade costs and advanced communication technology facilitated this development. By 2011 almost half of the world trade of goods and services were conducted through GVCs (compared to 36 per cent in 1995). As a result, intermediary trade has grown too. Moreover, rapid development of East Asian economies (China, the Republic of Korea and Thailand), that formed so called Factory Asia, promoted international trade even further. Overall, growth of global value chains and trade in international networks result from supplying primary commodities for industrial production (WTO report, 2015).

Much of those trade flows are conducted through trade intermediaries. For example, in the 90s in Japan, 40 percent of exported goods and 70 per cent of imported goods were bought and sold through intermediaries (Jones, 1998 in Abel-Koch, 2013); whilst Hong Kong had 50 per cent share in intermediating China's exports to the rest of the world (Feenstra and Hanson, 2004 in Abel-Koch, 2013). Nowadays, 22 per cent of current exports from China, 11 percent of Italian exports are also handled through intermediaries (Ahn, 2011) and 17 per cent of Turkish exports use intermediary services (Abel-Koch, 2013).

2.2.4 Upstream Supply Chain Actors

The upstream supply chains are much decentralised in the face of information asymmetry, uncertain demand, and limited resources. The companies in upstream supply chain networks commonly are making decisions in their own interest rather than for supply chain benefit (Long, 2016). It is important to review the roles, functions and relationships among different companies in upstream supply chains.

Three types of channel relationships have been defined – direct supply chains, extended supply chains and ultimate supply chains (see Fig. 2.6) (Mentzer et al., 2001). Some authors characterise upstream supply chains as extended supply chains due to multiple tiers of supply chain networks (Steinfield et al., 2011), however, commodity supply chains are better characterised as the ultimate supply chain because cross-border transactions and long

distance shipments of commodities involve numerous participants, financing and third party service providers.

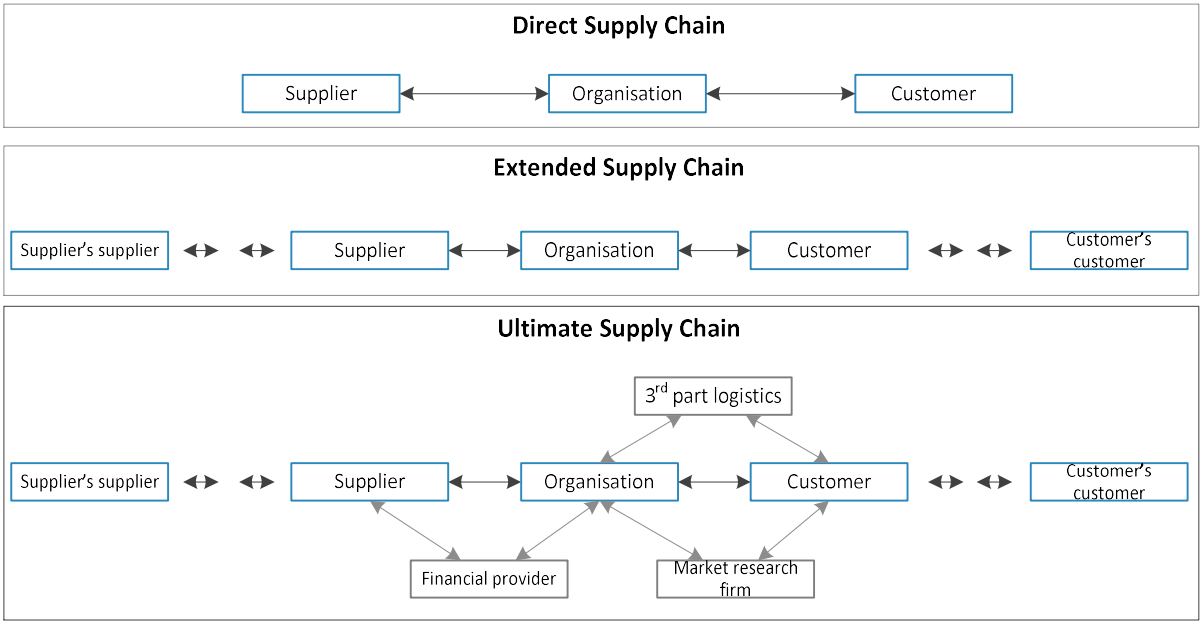

Figure 2.6 Types of Channel Relationships (Mentzer et al., 2001)

Bryceson (2009) proposed the following classification of companies in the agricultural supply chains:

Input suppliers – chemical and fertiliser companies

Service suppliers – companies involved in the delivery of goods such as shipping companies, inspection companies, banks, research and development organisations, governing bodies, and consultants. These participants play a strategic role in commodity trading even though they are not directly involved in the trade operations. Price is usually a key parameter in selecting suppliers, but other qualitative characteristics such as speed of document processing and completion can play their role (transport and storage companies like MSC, FedEx, TNT, CWT, etc.).

Producers – growers and farmers commonly located in developing countries and represented by smallholder farmers in agricultural supply chains (Lee et al., 2010, An et al., 2013). Most smallholders rely on farming for their livelihood and are not able to commercialise the production. The farmers are faced with high transaction costs, low technological

advancements, lack of market knowledge and access to finance to support their operations (Kilelu et al., 2016).

Wholesalers/Distributors – firms who buy and sell goods at profit without making any modifications to the product (Sysco, Vestey Group, Shenzhen Agricultural Products Co Ltd).

Trading organisations – in upstream supply chains occupy the position between the producers of commodities such as farmers and buyers – manufacturers providing the link between supply and demand worldwide. Traders are required to be very flexible to provide markets for both buyers and sellers to trade at every point in time given that farmers rarely sell when the downstream processors are ready to buy and vice versa (Beck et. al., 2007). (companies such as Cargill, Louis Dreyfus, Ecom)

Processors and manufacturers – companies that process and transform commodities into goods such as fabric mills and roasters, including companies such as Kraft, Mars, Cadbury, Unilever, etc.

Retailers – Supermarkets such as Tesco, Carrefour, Wallmart.

International organisations – international organisations are private or state-owned organisations that are involved in the control and arbitrage of international trade. The governing institutions are different for various commodities. The international organisations participate in negotiations of contract rules, settling disputes that arise between counterparties during trade (Bair, J. 2005). The contract rules basically cover performance, quality, shipment schedule, payment terms, and damages during trade. Nevertheless, these rules are often adjusted in response to changes in technology, market fluctuations or precedents during dispute resolution (Bernstein, 2001). Some of the international organisations involved in cotton trade supply chains include the American Cotton Shippers Association (ACSA, USA), the Cotton Association of India (India), the China Cotton Association (China), the Liverpool Cotton Association renamed the International Cotton Association (ICA, UK). Larger international organisations such as the World Trade Organisation monitor the rules of trade for all commodities between nations.

Agents/brokers - third party mediators, whose roles are not always noticeable, but they are important in most commodity chains. Their functions include maintaining communication flows between farmers and large merchants, but also help to source financing for farmers, making transportation arrangements and consolidating products from multiple farmers (Banker et. al., 2011). Agents have access to producers/farmers in interior markets on behalf of the traders. In addition to giving producers knowledge of the workings of the market, agents also play the role of consultants to the farmers, telling them what varieties to grow and whom to sell to, how to access loans and when to redeem them (Ruh, 2005). The choice of an agent can be central to the success or good performance of a trading contract as they hold broad knowledge of their markets, local practices, and buyers' requirements (Beck *et. al.,* 2007). Brokers work within a specific geographical location, bringing together buyers and sellers and like the agents, they act as third parties (Beck et al., 2007). In rubber supply chains, they mainly participate in the deals with high quality commodities that have specific demand to fulfil manufacturing requirements (de Haan et al., 2003). Furthermore, in commodity markets, product quality can be broken down into three categories: product-oriented quality (physical characteristics of goods); process-oriented quality (production and handling processes); and utilisation-oriented quality (i.e., subjective quality aspects as perceived by consumers).

Stakeholders in the upstream supply chains mainly have transactional relationships. The agreements between stakeholders are commonly made independently so the final clients have no knowledge of the arrangements. This relationship is meditated by price mechanisms where a competitive market allows parties to engage in the equitable exchange (Ouchi, 1980).

The upstream supply chains are heavily reliant on the relationship between stakeholders so communication and trust between players requires particular attention. Recent studies of the agricultural and food supply chains (Ortmann and King, 2010; Stevenson et al., 2011 in Olson, 2013) show that better communication helps avoid or reduce transaction costs and increase efficiency and value and thus reduce risks for the supply chain (Olson, 2013). The relational aspect of the supply chains will be further reviewed in this chapter.

2.2.5 Complexity of Upstream Supply Chains

Upstream supply chains are described as complex; they are confronted with multiple risks related to market and price fluctuations, dependent on the world political situation and are seasonal in nature, which means they are often reliant on weather conditions (Pirrong, 2010; Geman, 2012), lack or incompleteness of information (Marimin et al., 2017). Supply chain complexity is one of the main sources of supply chain disruptions (Cantor, 2014). The main sources of upstream supply chain complexity include:

Supply chain structure. The cross-border transactions and import-export regulations are some of the biggest sources of complexity in upstream supply chains. The trade agreements between countries have been widely discussed in the literature (Lynch, 2010; de Boyrie and Johns, 2013; Kawabata, 2014). Trade agreements have been used by countries to attract specific categories of goods or restrict the influx of products that they produce internally. On the one hand, this allows countries to access any commodities or specific qualities of products that they need regardless of seasons or location of the goods. On the other hand, export and import restrictions are often used as a way to apply economic pressures to execute political leverage, for example, to impose sanctions (Bode and Wagner, 2015)

Transportation-related issues. Secondly, transportation-related issues have been highlighted to contribute to supply chain complexity due to long distances between locations of commodity production to commodity manufacturing. High costs for freight, handling and storage are applied here, involving high risks of delays, errors, damages, and loss of goods. Additional stakeholders and suppliers such as inspection companies are also getting involved in the chain. Effective internal company management as well as external supply chain management are vital (de Haan et al., 2003). Low profit margins currently characterise trading activities in upstream supply chains (Lowe and Preckel, 2004). Cost management and risk management are an important part of the operations within upstream supply chains and are discussed later in the chapter. Essentially, many of the value-adding activities within these supply chains are related to effective shipping and logistics and all related services (Usuga et al., 2012; Cantor et al., 2014).

Number of supply chain participants. One of the main definitive aspects of complexity is the number of participants in the given system. Partners in the upstream supply chains mainly have transactional relationships. The agreements between counterparties are commonly made independently so the final clients have no knowledge of the arrangements. This relationship is meditated by price mechanisms where a competitive market allows parties to engage in the equitable exchange (Ouchi, 1980).

Gino et al. (2008) proposed a framework for managing operations using a behavioural management lens. They claim that "only careful examination of behavioural and cognitive factors can shed light on differences in operational performance such as productivity, efficiency and flexibility". The authors suggest that this element adds even more complexity to the picture and propose that two categories of enquiry need to be considered – the individual's characteristics and the properties of groups and the organisation.

Cooperation between participants in the supply chain has been described as an essential part of upstream supply chains (Petersen and Chapman, 2000; Saldanha et al., 2013) and claimed to help mitigate risks (Rozatocki, 2009). Supply chain management supports the idea that independent firms can create additional value by cooperating 'beyond their own short term interest' (Handfield and Nichols, 1999). However, the issues associated with information sharing and competitive advantage are still restricting collaboration efforts in the supply chains (Grubic and Fan, 2010; Samaddar et al., 2006). Despite concerns raised, cooperation facilitates process optimization from producing raw materials through intermediate participants and processing stages to final consumption (de Haan, 2003; Ercsey-Ravasz et al., 2012; Abel-Koch, 2013; Chen et al., 2015).

Additionally, **demand forecasting** (Lowe and Preckel, 2004; Kruse, 2010; Goel and Gutierrez, 2011) and **inventory management** (Jain et al., 2013; Kouvelis et al., 2013) have been highligthed in the literature.

Bryceson and Pritchard (2003) presented the network of counterparties and transactions in upstream supply chains (see Fig. 2.7).

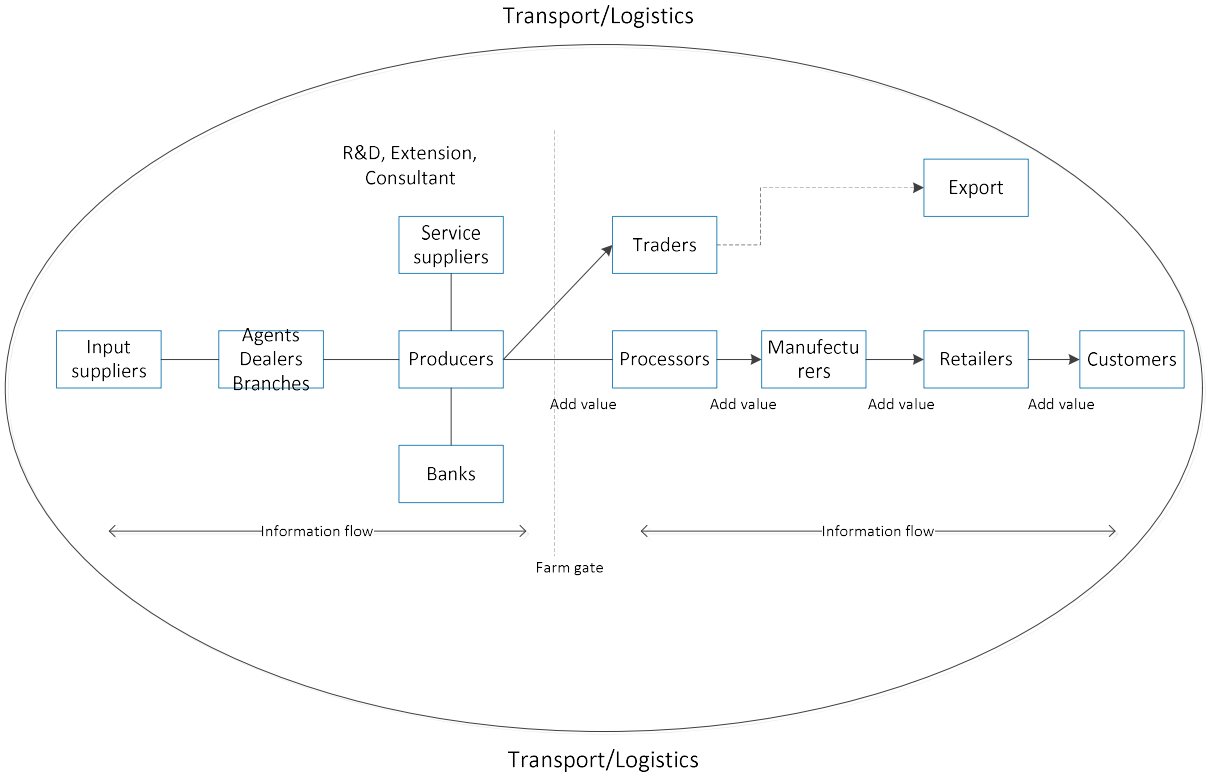

Figure 2.7 Agri-business supply chain network (Bryceson and Pritchard, 2003)

The information and product flows between participants show that the uncertainty is created by the availability of some information to farmers rather than to versus other participants in the supply chain. Moreover, the presence of export markets through the 'trader' is creating a non-linear structure of the supply chain and additional complexity.

2.2.6 Examples of Upstream Commodity Supply Chains

The following section provides an overview of the research of commodity supply chains used in this research. Cotton supply chains have been widely researched due to the scale and impact of commodity on the industry. Coffee supply chains and rubber supply chains gain more interest in recent years due to wider sustainability and traceability concerns.

2.2.6.1 *Cotton Supply Chain*

Cotton supply chains have been widely presented in the literature and provide a suitable example of a complex supply chain (Jap, 2001; Ercsey-Ravasz, 2012; du Toit, 2014). Cotton is presently one of the most cultivated crops in terms of land allocation (Burkharbaeva, 2009) and its production has risen continuously, with a significant rise between the 1950s to date, from 6.6 to 25.2 million tons (Edwards et.al., 2007). Some countries are still heavily reliant on incomes from this crop. For instance, cotton trade in countries in West and Central Africa accounts approximately for 40 per cent of total merchandise and contributes about 8 per cent to their GDP (USDA).

Cotton is planted from seed and normally survives in warm areas with high rainfall or irrigation. Farm inputs for cotton cultivation also include: fertilisers (NPK), whose requirement differs from region to region; water requirement for cotton plants, which is basically supplied through irrigation; and pesticides to control diseases and pests common to cotton plants. Cotton takes about 200 days to mature before it can be harvested either manually by hand-picking or mechanically. Manual harvesting is predominant in African countries whereas in developed countries like the United States, Australia and Brazil, machines are used (Chaudhry, 1997). After harvesting, the balls are sent to the ginnery often located within the farm. The ginning process separates the white fluffy fibres from their seeds and these fibres are now referred to as lint. The lint is packed in bales and shipped to different countries where they can be further processed by spinning, drawing into thin threads, knitting, twisting threads together into yarns and weaving. Local collectors and co-operatives gather cottons from different small-scale farmers to accumulate large quantities that can be traded by large (international) merchants. Traders of cotton can either buy directly from the farmers or buy from the ginners. In some case, the farmer/producer integrates the ginning process into his business, whereas in other cases the ginner is a separate entity. International trading companies like Cargill Cotton, Allenberg Cotton, Chinatex, Olam International and Ecom USA buy from these local collectors or from estate farmers who produce in marketable quantities. The trading companies in turn sell to the spinners, who spin the lint into yarns before sending them to textile manufacturers for processing. The cotton supply chain and its main participants are displayed in Fig. 2.8.

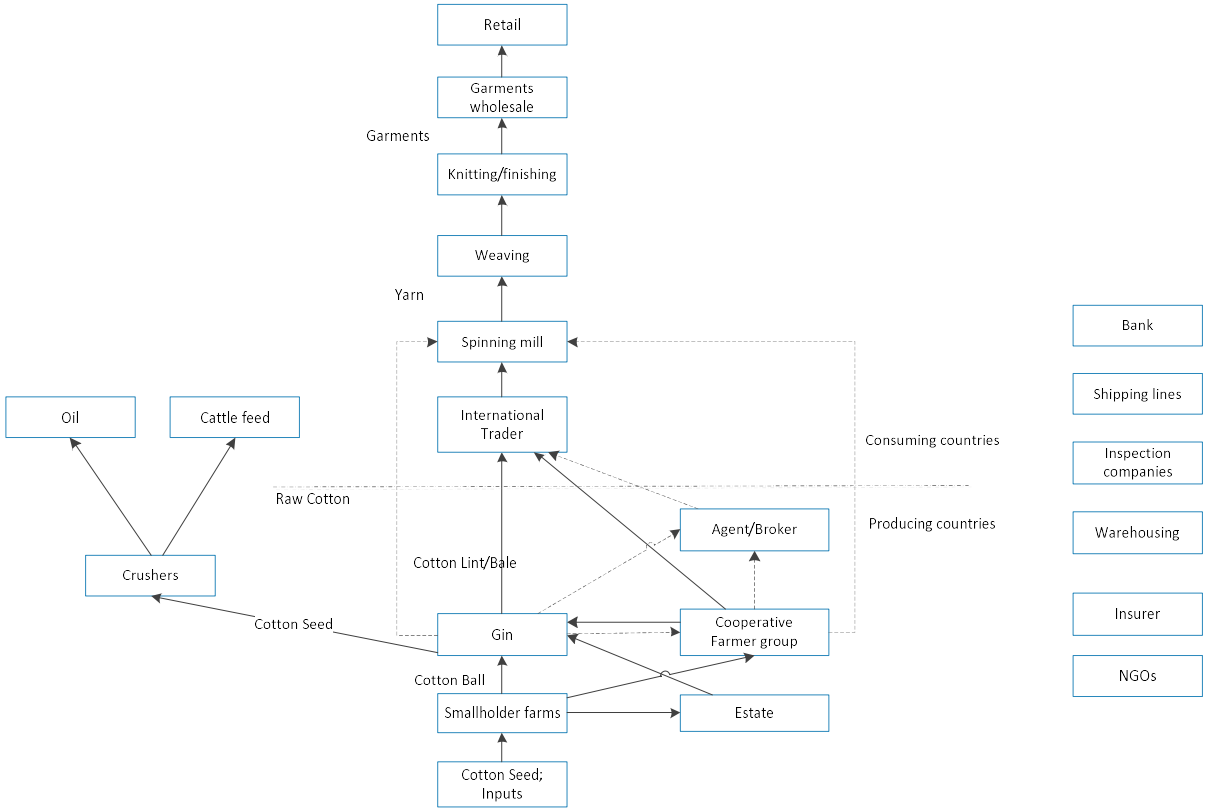

Figure 2.8 Cotton Supply Chain

The main cotton producing and exporting countries are presented in Fig 2.9. USA dominates the market and exports raw cotton because the processing factories are located outside of the country where the labour resources are much cheaper. India recently increased its export quantity due to the promotion of a proactive policy and encouraging the planting of cotton after the recession as well as proximity to China which is the largest cotton consumer. Four main cotton exporting countries in Africa include Burkina Faso, Mali, Benin and Chad (known as the C4 group). They are particularly dependent on the trade as it represents an average of 6.5% of their gross national product (GNP), and 33% of their export income (Ercsey-Ravasz, 2012). Cotton is a vital sector for many of these countries.

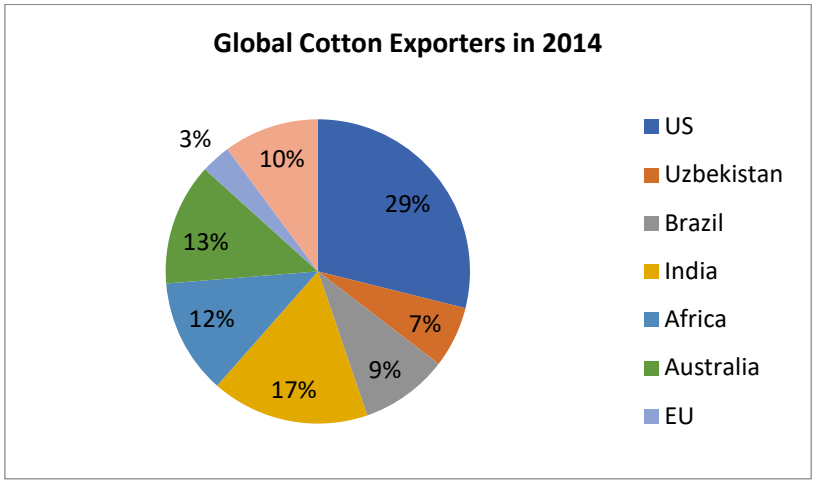

Figure 2.9 World's main cotton exporters in 2014 (ICAC website)

Cotton is a tradable commodity and the main futures exchange market is the ICE International Exchange. The exchange provides the mean to buy and sell futures contract of set benchmark cotton quality that were priced exclusively against US crops up until 2014. This created additional difficulties for trading companies and possibilities for price hikes to find exchange-approved US bales for delivery to the market, especially since the US cotton production is decreasing every year. New ICE futures accepts cotton from Australia, Brazil, India, the US and West Africa. Another important aspect of exchange futures contract trade is that delivery obligations need to be fulfilled by a certain date to a certain location. The new futures contract allows delivery points in the US, Australia and Malaysia.

Historically, the Liverpool Cotton Association controlled cotton contract rules when Western states dominated cotton trade. However, the situation changed in the early 2000s when China gained significant influence on the global scene. Since then, global powers began a dispute over which contract rules should govern global trade, involving the United States, China and India. The LCA in 2004 re-branded itself as the International Cotton Association (ICA) in an effort to retain institutional power over contract rules amidst the growing opposition from China and India (Quark, 2011). It is however concluded that the ICA rules have been increasingly accepted internationally as the global cotton contract rules (Alpermann, 2013).

2.2.6.2 *Rubber Supply Chain*

Another example of a supply chain in which production and consumption is globally dispersed is rubber - 95% of natural rubber is grown in Asian countries, while the export of rubber products is carried out by developed countries (75%) (de Haan et al., 2003). An important characteristic of such raw materials is that they have a variety of applications ranging from cheap goods like rubber footwear to sophisticated products like gloves for medical use.

In the supply chain for natural rubber, latex is collected from plantations and is then processed into derivative products like Ribbed Smoked Sheet (RSS) and Brown Crepe (BC) (Marimin et al., 2013). The rubber has specific international standards for grade descriptions; standardised Test Certificates (quality certificates) are used worldwide for quality assurance of goods bought and sold. Rubber is produced in batches which also facilitates the traceability of goods.

The main participants in the rubber supply chain include rubber farmers, village collectors, sub-district middlemen, traders and crumb rubber factories (see Fig 2.10). Village collectors collect latex from growers or rubber tappers. Sub-district middlemen bridge the gap between the village-level rubber economy and economic activities at the district level. Traders/brokers buy rubber from middlemen and rubber crumb factories (Marimin et al., 2005). There might be other intermediaries that help with the export of rubber or the import of rubber in the manufacturing country (Marimin et al., 2013). The communication systems between primary participants of the rubber supply chain are well integrated. The information from exporter and rubber collector goes to processing plant and in reverse. The exporter and factory communicate via telephone to find current rubber price and to agree on delivery dates. However, the participants have different interests in the supply chain. Farmers are striving to increase income, the manufacturing industry needs to acquire high quality raw materials, the final consumer needs high quality products in line with standard but also at a reasonable price; research and development are looking into ways of further development and innovation of products; and government is hoping to increase exports earnings from rubber. Understanding and managing the relationships in the rubber supply chains is important to satisfy all of these needs.

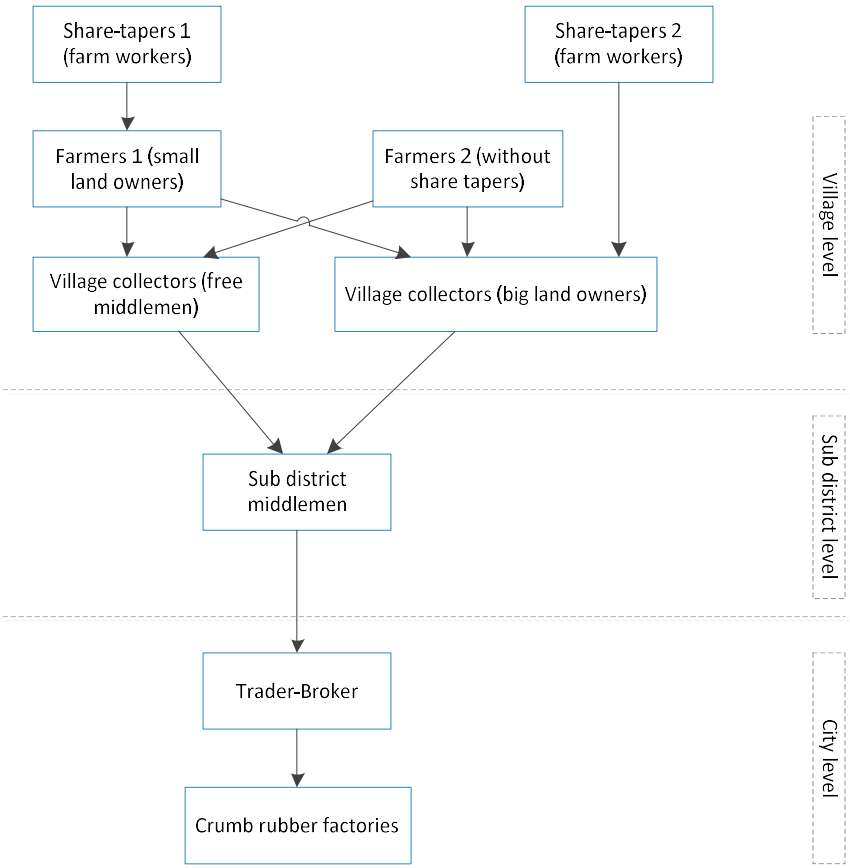

Figure 2.10 Rubber supply chain (adapted from Arifin, 2005)

The international organisation that represents the global rubber industry is called The International Rubber Study group (IRSG). The group collects data on the production, consumption and economic condition of rubber. It is also working on the definition of sustainability standards.

The rubber is traded on the Singapore Commodity Exchange (SICOM), Shanghai Future Exchange (SHFE), Tokyo Commodity Exchange (TOCOM) and others. The price of natural rubber is affected by a number of factors such as dynamic changes in the fundamental factors of economic development, economic shocks or policies, and speculative activities on futures markets (Bustanul, 2005; Marimin et al, 2014).

2.2.6.3 *Coffee Supply Chain*

Coffee is a tropical tree crop commodity grown in many parts of the world. There are basically two varieties of coffee trees: Arabica and Robusta, and four varieties of coffee beans: Arabica Parchment, Arabica Cherry, Robusta Parchment, or Robusta Cherry. Robusta coffees are grown in low altitudes and are known to have less flavour than the Arabica coffees. However, Robusta coffees have greater strength than Arabica which are grown in high altitudes. Arabica coffees can either be wet-processed or dry-processed and are usually more difficult to grow and process than Robusta which is mainly dry-processed. Arabica coffees are considered to produce better coffee than Robusta coffee. Coffee roasters often blend a combination of coffee varieties to obtain a consistent quality of coffee (Gilbert, 2006).

Coffee is cultivated on both small scale and large scale by small farm holders and large scale farmers around the world respectively. Small-scale productions of coffee are common in African countries like Uganda, Ethiopia and Burundi, whereas large scale productions are prevalent in Kenya and in western regions such as Latin America (Gilbert, 2006).

Coffee trees begin to produce fruits (cherries) usually within 3 to 5 years after planting, depending on the variety. Coffee harvesting can either be done by hands or by machine in two ways. The first is strip picking, which entails stripping off the branches of all cherries, which can be done either by hand or by machine. The second, known as selective picking can only be done manually. It involves picking only ripe cherries individually. It is highly labour intensive and therefore is priced more. This type of harvesting is used mostly for finer Arabica beans.

After harvesting, the beans are processed before they are sold or exported for roasting. Wet processing involves pulping the coffee cherries to expose the beans, fermenting, and washing to separate the pulp from the beans. The washed beans are dried to produce dry parchment coffee. On the other hand, the dry process simply involves drying the harvested coffee cherries which gives the dry cherry coffee. At this stage, both types of coffees are cleaned, sent to the mill for hulling to remove what is left of the cherries from the beans. The beans are then sorted and bagged for storage. When stored in a dry cool condition, coffee beans can remain useful for over two years. The stored beans are usually sold to industrial

processors, and sometimes to branded marketers through international traders. They are then exported to factories where they are further processed by roasting to produce the characteristic flavour of coffee, and then packaged. The roasted coffee has a shelf life of 2 weeks while ground coffee can last for as little as 15 minutes. Thus, the ground coffees are usually packaged in vacuum cans to retain freshness.

Coffee is one of the largest tradable commodities in the world. The global production of coffee in 2015/16 been forecasted to be 152.7 million 60 kg bags (USDA). The coffee consumption is increasing yearly and especially the market share of specialty coffee (high grades, espresso). The organic coffee industry is also expanding. Organic coffee requires specific growing techniques. Quality management is a large concern for coffee supply chains. Coffee producers need to employ new technology to adapt to weather changes and to satisfy more demanding customers that are more aware of high quality coffee and especially need to know that is was sourced responsibly. Collaboration has been recognised to help in efforts to improve quality of coffee worldwide. Additionally, the position of the farmer in the complex supply chains can be overlooked, but collaboration efforts and Fair trade movement is working to guarantee coffee growers 'liveable wage' (www.ico.org).

The coffee trading supply chains are governed by the International Coffee Organisation (ICO). It was established in 1963 after the first International Coffee Agreement was passed in 1962. There were three objectives of that agreement - to create a balance between supply and demand to ensure adequate supplies of coffee to consumers as well as providing markets to producers at fair prices which should allow for stability between production and consumption; secondly, to reduce fluctuations in coffee prices; and thirdly, to raise the power of exporting countries through maintaining price levels and increased consumption. The agreement was further changed in 1968, 1976, 1983, 1994, 2001, and then in 2007. The 2007 agreement intended to strengthen the ICO's role as a body for inter-governmental consultations, enhance international trade through better transparency and availability of relevant information and also to promote sustainability in the coffee chain for the benefit of all stakeholders (International Coffee Organisation, 2013).

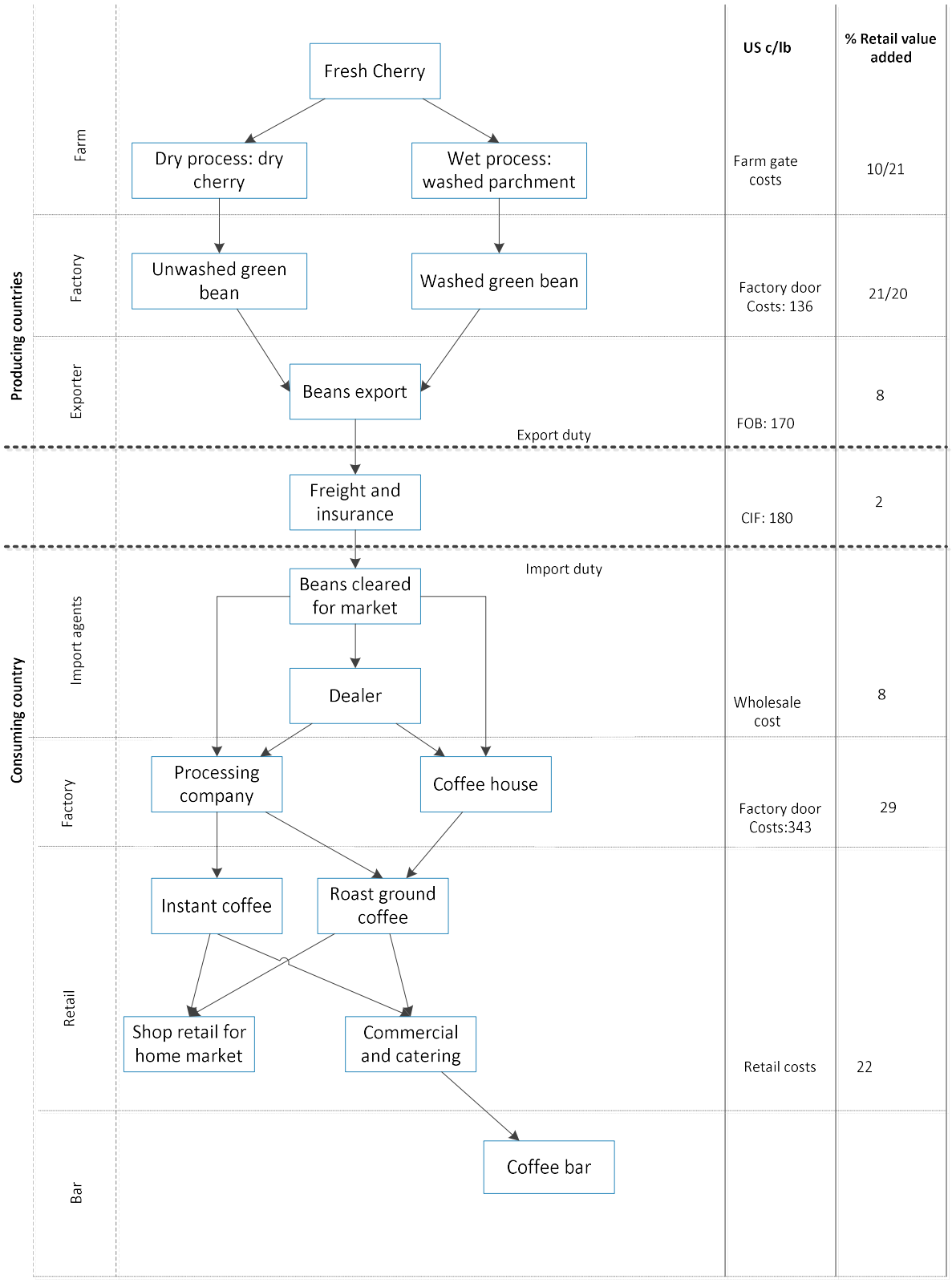

Figure 2.11 Coffee Value Chain (Kaplinsky, 2001)

2.3 Upstream Commodity Supply Chain Challenges

This section focuses on the challenges identified in the literature for operations in upstream commodity supply chains. Specific attention is given to four aspects: governance, access to finance, operational challenges and supply chain risk management. Table 2.3 summarises the main challenges highlighted in the literature for upstream supply chains. The four aspects found most critical for commodity supply chain management will be reviewed in designated subsections.

Table 2.3 Upstream supply chain challenges

Challenge	Sub category	Description (Literature)
Supply chain governance	Transactional governance: Transparency	Lamming et al. (2001); Zhang et al. (2006); Broll & Eckwert (2006) ; Bevilacqua et al. (2008); Beddington (2010); Steinfield et al. (2011); Hakanson and Dow (2012); Weichselbaum (2012); Chen and Deng (2013); Tong and Wei (2014); Ibrahim et al. (2015); Horvat et al. (2015); Rached et al. (2015)
	Relational governance: Information sharing	Popp (2000); Samaddar et al. (2006); Goswami et al. (2011);
	Contractual governance: Regulation and arbitration	Rajan (2003); Kaplinsky (2005); Pelaez and Pelaez (2008); Lynch (2010); Quark (2012); Kistruck et al. (2013); Vieira (2014)
Financial	Market/price volatility	Geman (2005); Goodwin et al. (2005); Wang and Tomek (2007); Robinson (2008); Haile and Pugh (2013); Haile et al. (2014); Hochman et al. (2014); Chen et al. (2014); Ridley and Devadoss (2014); Boroumand et al. (2014)
	Access to Finance/Trade finance	Petersen and Rajan (1997); Deng, Z. & Hou (2014); Chen and Tang (2015); Auboin (2016); Kowit et al. (2016)
Operational	Costs	Kazaz and Webster (2011); Goel and Gutierrez (2011); Kopparapu (2014)
	Storage/warehousing/inventory	Kouvelis (2009) ; Secomandi (2010) ; Tanweer et al. (2014); Borodin et al. (2014)
	Distribution/Logistics	Klein and Rai (2009); Casaburi et al. (2013)
Risk management	Environmental uncertainty: Financial, market, operational risks	Hussain et al. (2005); Pirrong (2009, 2014); Hollis (2011); Geman (2012); Hoffmann et al.

		(2013); Goh et al. (2013); Kilubi and Haasis (2015)
	Behavioural uncertainty: Network risks	Fung et al., (2007); Trkman and McCormack (2009)

2.3.1 Supply Chain Governance

Liberalisation of commodity markets in Africa, Asia and China created new opportunities, opened borders and increased competition. Globalisation allowed for continuous operating cycles, but at the same time demanded more expensive investments for inventory holding and been slow planning (Haapasalo et al., 2006). The commodity supply chains are characterised as buyer-driven and are required to be flexible with regard to the quality of goods required in order to satisfy customer needs (Haapasalo et al., 2006). Challenges have been introduced to upstream supply chains by efforts to regulate the industry and currently existing complex governance structures. The cross border regulations can be hard to navigate for the companies, but the absence of strong legal institutions in some countries or areas of trade, buyers and sellers are faced with strong possibilities of unfair contacts and limit the number of partners they are willing to deal with (de Soto, 2000 in Kistruck et al., 2013). A significant analysis of supply chain governance and regulating bodies has been presented by Quark (2012) with regard to cotton supply chains. The role of international organisations and especially the World Trade Organisation were discussed. International Organisations are private or state owned organisations that control the import and export of commodities (Quark, 2011). Different commodities might have different international organisations. In commodity trading, such organisations are responsible for negotiating standardised contract rules and terms, and settling disputes that arise in the trade between traders and manufacturers. Trading contracts normally cover quality, payment, delivery terms and conditions on delays, repudiation and arbitration of disputes. These rules are regularly reviewed in response to changes in technology, market changes and political changes (Bernstein, 2001). Keeping in line with current regulations is essential in commodity trading (Lynch, 2010).

Aramyan and Zhang (2009) investigate agri-food supply chains in China and outline a comprehensive framework of supply chain governance. As a result of globalisation, most industries rapidly become multinational players and the agricultural sector is no exception. Supply chains span across the borders, integrating the global markets. Traditional agricultural production practices combine with modern markets such as local groceries or supermarkets. Two types of governance are considered: contractual and relational. Contractual governance is characterized by more formal, explicit type of relations. In contrast, relational governance is represented by informal, trust-based relationships. One of the objectives of their research is to look into farmers' linkages within the chain and reveal possible influencing factors that affect their decisions. Contractual governance is itself subdivided into market and production contracts. Relational governance is attributable to social interactions and is approached from the point of view of trust and cooperation.

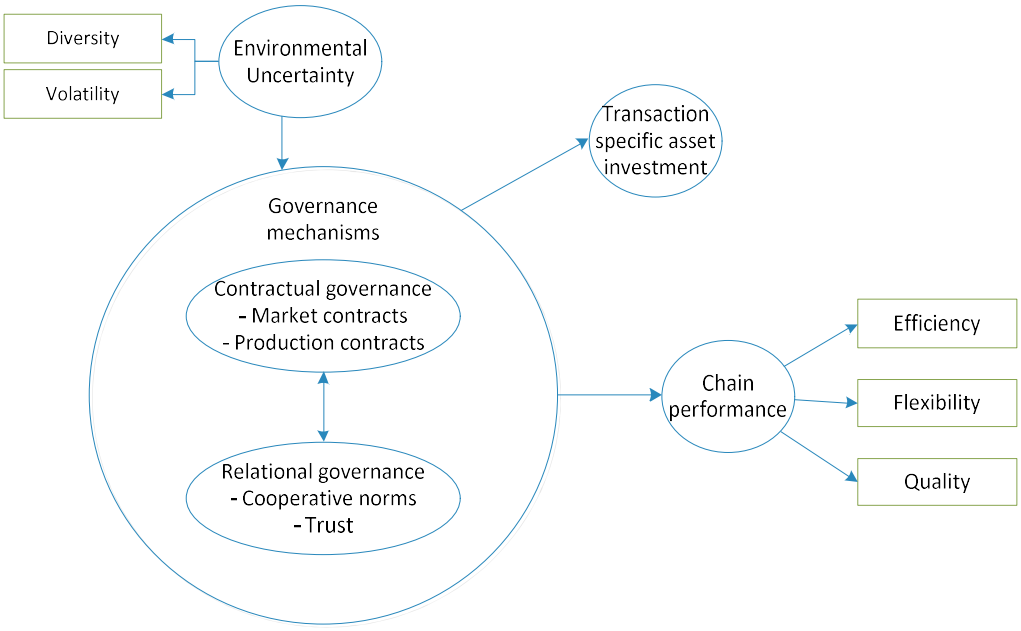

Figure 2.12 Conceptual model for governance structure in agri-food supply chain (Zhang and Aramyan, 2009)

This framework was developed by authors using relational theory and transaction cost theory and designated to assist Chinese agri-food suppliers and retailers to implement efficient governance practices. Contractual and relational governance are both applicable in this research and both contractual governance and relational governance are present in most commodity supply chains.

Dolci and Macada (2014) outlined the model that provides relationships between supply chain governance, information technology investments and performance. Supply chain performance and governance are greatly influenced by IT solutions. Rapid development, improvement and ubiquitous integration of IT throughout the market raise the bar for market participants, so that they could hold a competitive edge as well as gain an advantage. Computer-based technologies drastically increase data processing capabilities and logistic operations in order to allow for more efficient supply chain governance and better performance. As the studies linking supply chain governance to supply chain performance have been quite scarce, their paper proposes a model to determine the degree of influence of IT investments on these two aspects. In particular, agency theory can be considered as a contractual type of SCG, where there are contracts established between the principal (leading firm) and the agents (lower level suppliers). There exist a number of information systems to help manage contracts. Additionally, transaction cost theory demonstrating transactional governance, as well as resource dependence theory focusing on inter-organisational symbiosis or relational governance are all subjects to appropriately specialised IT service (p. 221, Dolci and Macada, 2014).

After conducting qualitative and quantitative method approaches it was concluded that IT was playing a crucial role in the model key indicators regarding supply chain governance. For one, IT improves and speeds up the management of the processes related to supply chain governance. It was determined that supply chain performance can be successfully measured with market, financial or operational tools, which highlights the strong influence of IT investments here as well.

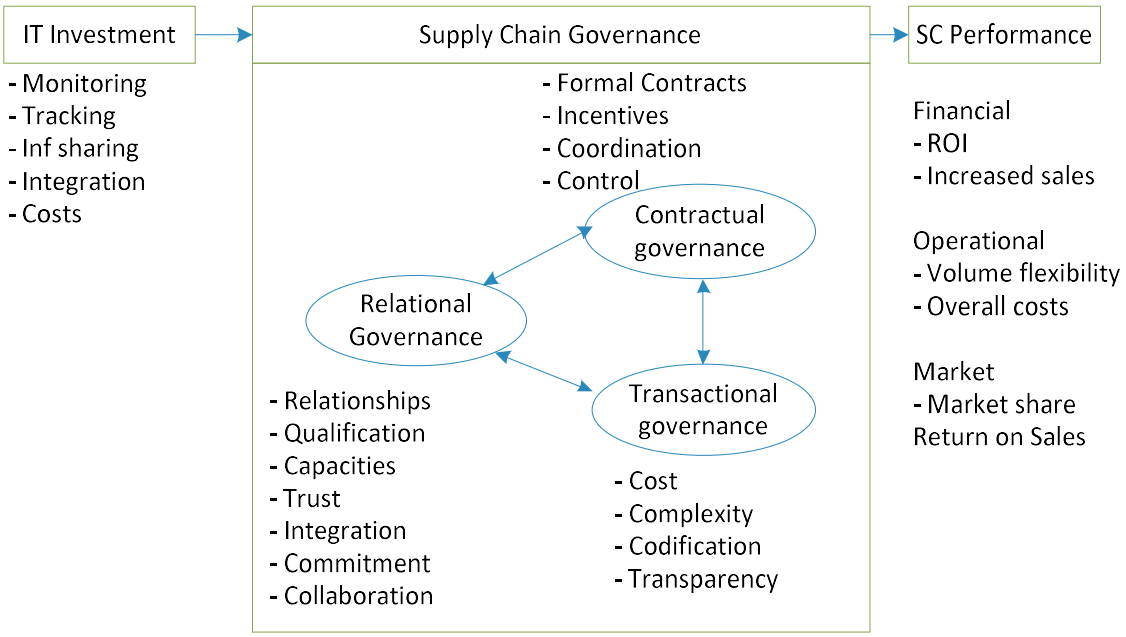

Figure 2.13 Supply chain governance model (Dolci and Macada, 2014)

Carvalho et al. (2016) presented a view of governance structures in the coffee supply chains. Specialised coffee shops are targeted at more sophisticated customers by providing higher quality product with unique characteristics, as well as establishing a unique set of relations. They constantly strive to improve their standards to remain 'above the herd' in quality and treatment. Such a highly specialised strategy refines the customer base to a much narrower degree, therefore creating more sparse but in the same time a more loyal customer base. This approach could be classified under relational value chain governance. Traditional coffee roasters, on the other hand, have lower complexity of information exchange between coffee shops and target a broader customer base. As a result, there is lower dependency between buyers and the roasters. In this case, a market type of value chain governance is better suited (Carvalho et al., 2016).

Carvalho's (2016) study has shown that market type governance of traditional coffee makers is dominating. As the coffee blends are produced on an industrial scale, they are readily available, cheap and easily replicable. This creates favourable conditions for buyers and suppliers to swap partners. Due to the lower abundance of coffee blends in specialty coffee shops, they are harder to replace and hence roasters require longer term sustainable

relationships with suppliers that provide this type of product. Thus, relational type of value chain governance can guarantee better performance under these conditions.

2.3.1.1 *Ethical Concerns, Visibility and Supply Chain Sustainability*

Commodities trading, particularly the agri-commodities trading, have been under lots of scrutiny. The special interest in social and environmental links within the supply chains of commodities, particularly due to the effects of globalisation and industrialisation, resulted in the search for alternative production and trading practices that are socially and ecologically sustainable (Moore, 2004). Identity preservation of products in international trade channels is increasingly becoming an integral aspect of product quality in international trade (Eswarlal, 2014). Of the various alternative-trading initiatives, the very common ones specific to agri-commodity chains are the Fair Trade movement and the Organic trade movement. There has been substantial growth in the alternative trade of commodities over the past years. Redfern and Snedker (2002, in Moore, 2004) gave an estimate of the Fair Trade worldwide to worth US$500 million. They also claim that it was likely to be more than the value estimated. The estimated world market of organic products is said to be worth over $10 billion (Moore, 2004). As for final consumers, the trends in demand are changing – consumers are expecting convenience and low prices as well as knowing where the products were sourced from and what environmental impact they have (Weichselbaum, 2012).

The ethical implications in the upstream supply chains have been widely discussed. Fair trade movement received some attention (Chen and Deng, 2013; Langen and Adenaeuer, 2013), as well as supply chain traceability (Caridi et al., 2014; Barratt and Oke, 2007) and corporate social responsibility (Quark, 2008; Cardebat and Dumitrescu, 2013; Sodhi, 2014 and 2013; Besiou and Wassenhove, 2015).

The most recent addition to the global efforts to address these sustainability issues was the Modern Slavery Act which is designated to tackle slavery at any levels of the supply chain. Such regulations are aimed at encouraging companies to eliminate modern slavery from their supply chains with the focus beyond first tier suppliers (New, 2015).

The trading companies as a central participant of upstream supply chains have to accept the

level of responsibility over some environmental as well as social/ethical issues during resource extraction. Global hunger, unsustainable use of water, biodiversity loss in tropics as well as child labour and modern slavery are among some of the sustainability issues that need to be addressed (Weichselbaum, 2012).

2.3.2 Challenges Associated with Access to Trade Finance

It has been recognised that lack of access to finance is one of the most important challenges when it comes to cross-border trade (Auboin, 2016). Trade finance is described as "short-term financing of international trade which supports and enhances the physical flow of goods and services" (Kowit et al., 2016). Trade finance mitigates the risk of non-payment by the partners and increases confidence in trade relationships for exporters and allow for extended credit for importers. Additionally, the increase of cross border trade reflected in increased exports can improve a country's position in the international capital markets and larger access to finance coming from public and private credits. Trade finance can be also viewed as 'mechanism of economic development which can contribute to a country's sustainable socio-economic prosperity' (Kowit et al., 2016).

Financial institutions are some of the most influential players on the global scene. Global commodity trading is subject to specific financing requirements and risks due to international transactions. Maintaining the liquidity of funds throughout the trading cycle to bridge the gap between the time of payment for commodities purchased and the time of payment made by the buyer and payments for goods sourced from the farmers are facilitated through credit lines issued by the banks. Both domestic and international banks are involved in financing and risk cover of trading operations. The credit lines are opened based on trader's solvency, balance sheets and sound internal risk control structures, general standing and overtime performance record, security available under the transaction and related legal aspects of it (Beck, 2007). The most common type of financing provided by banks is 'transactional finance' which is generally based on the strength of the export contract. The criteria for strength of export contracts used by banks, in cotton trade for instance, are the buyer's solvency and reliability, the status and terms of the export sales contract, the quality, storage,

transportation and processing of the cotton, the price and currency risks and the trader's ability to deliver the cotton as agreed (Beck, 2007). The transactional finance covers periods from the purchase of a commodity until the final payment produced by the buyer. A Letter of Credit is the most commonly used tool of trade finance for international commodity trading. Here the bank assumes payment obligation for the buyer; payment will be affected at the time agreed by the bank regardless of the buyer's readiness to pay (Beck, 2007, Serena, 2015).

The access to finance by the commodity producers like farmers are of specific concern as they face rules and regulations when applying for loans and accessing information (Jensen, 2007). Availability of credits to farmers in developing countries allows for transformation of their practices and improvement of competitiveness. Olson (2013) raises questions of how much capital is actually available to farmers and how this will change their performance. The research provides a number of recommendations for addressing those issues from an economics point of view, however the practical application of those recommendations need further investigation.

International traders turn to domestic and international banks for finance and risk cover. Banks' readiness to provide credits are dependent on the trader's solvency, balance sheet, internal risk control systems, general standing and track record, security available under the transaction and related legal aspects of it (Beck, 2007; Asmundson et al., 2011; Kistruck et al., 2013).

The shortage of trade finance for international trade has been recognised to affect global trade flows (Auboin, 2016). The author highlights the lack of empirical work on trade finance due to limited data on the topic, but previous research allowed to make a link between financial conditions, trade credits and trade. For example, Bricongne (2012, in Auboin, 2016) showed that export-oriented firms are more reliant on external finance and get most affected by the crisis, and Auboin and Engemann (2013, in Auboin, 2016, p.6) found that "a 1 per cent increase in trade credit granted to a country leads to a 0.4 per cent increase in real imports of that country". Beck et al. (2012 in Kowit et al., 2016) also found that availability of trade finance positively affects economic growth and jobs creation and suggested that a 5 per cent increase in availability of trade finance could result in 2 per cent increase in production and employment. Moreover, Serena and Vasishtha (2015) conducted work to examine key drivers of bank-intermediated trade finance focusing on the role of global and country specific

factors. They found that global factors include financial conditions and global import growth whilst country specific factors include growth in trade flows and funds available for domestic banks. Kowit (2016) reviewed risks associated with trade finance for non-bank investors.

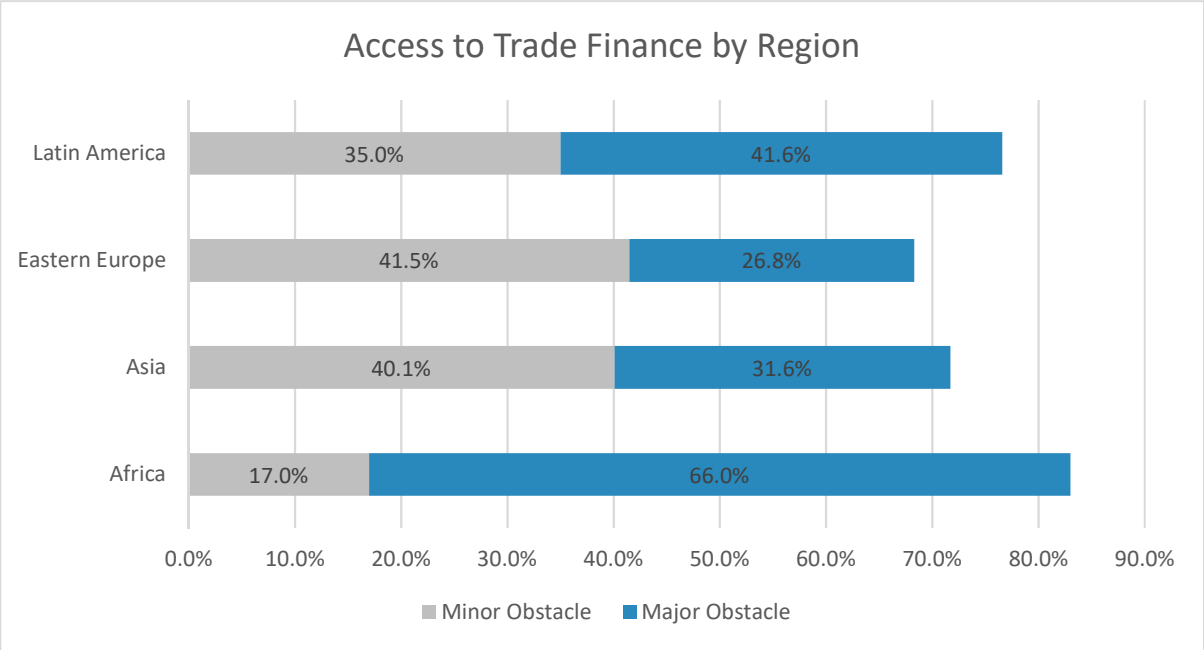

Figure 2.14 The extent in which access to trade finance forms an obstacle to company exports by region (Auboin, 2016)

The difficulties of companies in developing countries in accessing trade finance on affordable terms have been highlighted (Auboin, 2016). The risks of trading with low income countries is higher so the cost of doing business with these countries is greater too which leads to even less finance available to conduct trade. Moreover, some global banks have been reducing the links with local banks limiting the opportunities to find international counterparties to help trade flows in emerging countries.

Some of the factors that are restricting companies' capability to obtain trade finance include (Auboin, 2016):

- Interest rates/premiums too high
- Insufficient collateral or guarantee
- Long processing time
- Financial institution's requirements unacceptable
- No previous transactions/lack of business relationship

- Country has ‘high risk’ rating
- No law on receivables or invoice financing
- Documentation requirements are too burdensome
- No law on asset based lending
- Company records are incomplete/unacceptable

At the same time, the banks are faced with numerous risks when considering a loan for a specific transaction. The risks include political risk, commodity risk, currency risk and production risks (ICC, 2014):

- Anti-money laundering and client due diligence
- Basel regulatory requirements
- Low country credit ratings
- Issuing bank’s low credit ratings
- Previous dispute or unsatisfactory performance of issuing banks
- Constraints on bank’s capital
- Lack of dollar liquidity
- High transaction costs or low fee income
- Low company credit rating
- Insufficient collateral from company

The main trade finance instrument between developing and developed countries is Letter of Credit (LC), but leading trade finance techniques for agricultural needs in the agriculture sector is Warehouse Receipt Finance. It allows farmers, producers and traders of agricultural commodities to access bank credits based on warehouse receipts issued for commodities stored in approved warehouses. Fig. 2.15 presents the mechanisms of the International Finance Corporation (IFC) Global Warehouse Finance Program. The programme finances transactions in over 41 countries including Burkina Faso, Ethiopia, Ghana and Uganda and financed over $7.5 billion US Dollars of commodity transactions (Auboin, 2016).

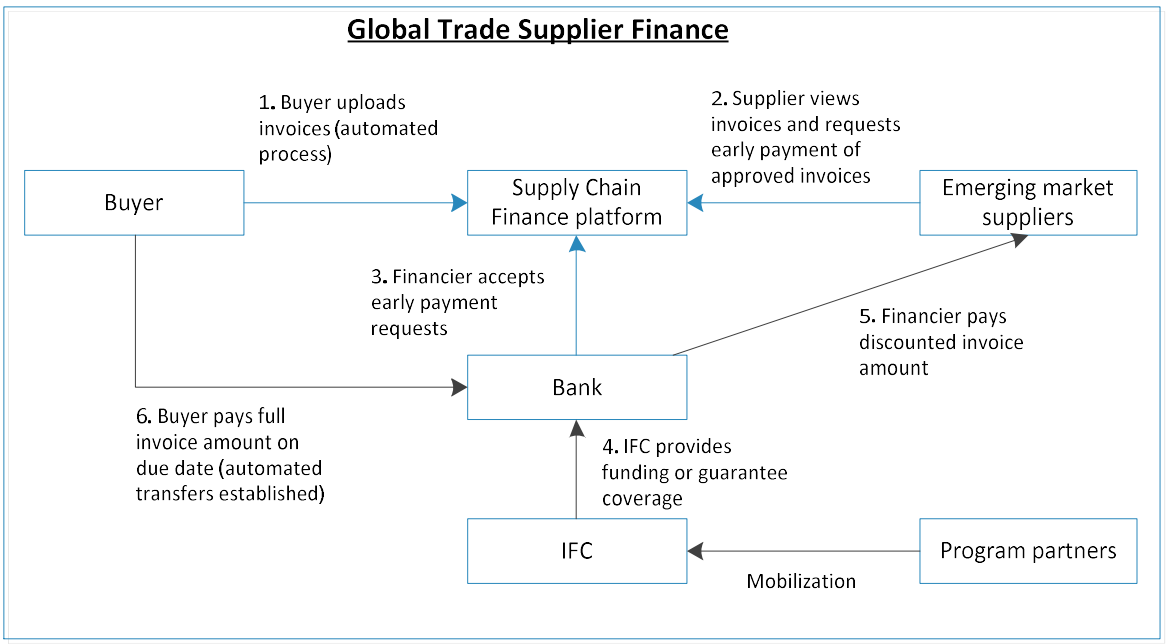

Figure 2.15 IFC's supply chain solution (Auboin, 2016)

The role of DSS in increasing the prospects for accessing trade finance for global commodity trading through reducing the risks that banks consider when issuing loans have not been previously reviewed. This indicates a need to further understand the various mechanisms and approaches that can facilitate access to finance by upstream supply chain stakeholders which is further addressed in this research.

2.3.3 Challenges Associated with Upstream Supply Chain Operations

Description of the operations involved in cotton trading supply chains by Beck (2007) showed that the movement of commodities from the point of purchase to the location of sale involves multiple participants (shipping lines, inspection companies, insurance companies and banks), documentation, scheduling and importantly at the lowest cost. The operational challenges include delivering on time to client requirements, storage of goods, availability of the qualities required, etc. These have to be managed daily and affect company performance the most. Previous research reviewed specific challenges in the transportation of commodities. De Haan et al. (2003) explain that high quality latex have to be kept in drums and then centrifuged a number of times. The inventory management is one of key aspects of company performance

and supply chain efficiency. The authors reviewed commodity storage (Kouvelis et al., 2009), inventory optimisation (Tanweer et al., 2014) and optimal trading with storage asset (Secomandi, 2010), and the impact of information systems on inventory performance (Rabinovich et al., 2003).

Supply chain operations need to adjust to dynamically changing environments and trade patterns, shipping and storage of goods (Olson, 2013). The inventory management becomes especially important when trying to stabilise annual consumption on the one hand and at the same time trying to reduce inventory levels, costs and management efforts. Transportation falls under the same rules (Olson, 2013). Operational challenges specifically relating to commodities trade include volume rateability – the speed of delivery, production and consumption needs (requirements to store goods, watch out for goods ageing) and scheduling – supply chain distances time lags in decision making and exposure to market fluctuations

Globalisation has also led to reduction of incomes due to increased competitiveness, cheaper and higher variety of food and clothing. Commodity producers are normally under most pressure due to high transportation costs of their goods for consumers. The value of their resources and resource availability comes into question. The quantity and quality of labour are not always easily accessible (Olson, 2013). Moreover, access to new technologies from machinery, seed development and information technologies determines the productivity of future crops for farmers. Investment into research and introduction of new technologies creates many opportunities but in developing countries can be restricted due availability of finance (Olson, 2013).

2.3.4 Supply Chain Risk Management and Market Volatility

Numerous studies identified market volatility as one of the main characteristics of the commodity supply chains (Larson et al, 1998; Ruh, 2005; Lynch, 2010; Donnet, 2011). The prices of commodities' products change daily and even hourly which exhibits dynamic behaviour (Chen et al., 2014, Fischl et al., 2014). Prices could change between the times the products are bought by a trader to the time they've been sold to compare to the time of actual export of goods. The uncertainty of prices require firms to better understand the

relationship between procurements, processing, shipping and other trade decisions and coordinate supply chain across time (Devalkar et al. 2011). For example, price can radically change between planting time and the time of harvest for agricultural commodities (Larson et. al., 1998). Market risks include:

- Basis risk – differences between prices on the same commodity in different markets
- Credit risk – counterparty will not perform in accordance with contract terms
- Operational risks – errors or inadequacies in the multiple systems or processes needed to structure, price trade, and manage physical positions
- Liquidity – no available partner to accept an offsetting position

Understanding of these underlying challenges of upstream commodity supply chains allowed identifying the key business drivers, risks and decision-making required by the trading companies. The commodity trader is adding value to commodity chains by effective management of these challenges, responsiveness to supply and demand shocks and optimisation of transportation of goods between geographic locations, delivering the goods according to agreed schedules and transformations of goods in form (for example blending different qualities of coffee to make new grade) (Pirrong, 2015). There therefore appears a definite need for the DSS that allow data storage, processing and analysis capabilities as decision support tools. The need for the DSS in commodity trading is further supported by the importance of availability not only of correct and up-to-date information about the market, but also analysis of traders' operational capabilities and other key performance indicators providing business intelligence capabilities.

2.4 Conceptualising Intermediary Commodity Trade

This section provides a definition and conceptualisation of intermediary commodity trading companies in the upstream supply chain and presents previous research on intermediaries in supply chains.

2.4.1 Definition of Supply Chain Intermediary

The concept of an intermediary is rooted in the economics literature – "an intermediary is an economic agent that purchases from suppliers for re-sale to buyers or that helps buyers and sellers meet and transact" (p. 135, Spulber, 1999). The intermediary settles and coordinates transactions, selects buy and sell prices, manages payment and keeps records for those transactions, and can hold inventory to maintain liquidity or availability of goods and services. In order to add more value to the product, intermediaries are involved in transportation, storage, re-packaging, assembling, and information distribution and quality assurances (Spulber, 1999).

The research to date is lacking a common definition of a trade intermediary and conceptualisation of intermediation in supply chains (Popp, 2000; Vedel and Ellegaard, 2013). Merener et al. (2015) describes a 'generic commodity trading firm' as a firm that provides an intermediation service during a marketing period of several months and involves agreeing and signing new contracts, payments, storage and shipments (Merener et al., 2015). Commodity trading companies are also often referred to as the 'middlemen' or 'economic agents' noting the contentious nature of the phenomenon (Goel et al., 2011; Biglaiser and Li, 2016). Middlemen are argued to create value through risk taking, enforcing terms of contract, economising on the physical cost of a transaction, but criticised for global sourcing practices and accused of high trade margins (Biglaiser and Li, 2016). Balabanis (2000, 2001, 2005) uses terminology export management companies and export trading companies to specifically refer to intermediaries specialising in the export of goods.

Intermediaries are commonly present in the markets where demand and supply 'have an element of randomness' to provide liquidity and readiness to buy or sell (p. 136, Spulber, 1999; Qu et al., 2015); Ahn et al. (2011) suggest that intermediaries are relatively more

important in markets that are more difficult to penetrate and have higher trade costs. In the context of high uncertainty, price setting to match purchases to sales is the main function of intermediaries. Additionally, Bailey (1998 in Wu, 2004) shows that in order to minimise transaction costs, intermediation in the market is preferred when the number of suppliers become numerous. Otherwise, disintermediation and direct exchange between buyers and suppliers is preferred. Abel-Koch (2013) conducted an analysis of the relationship between firm size and use of intermediaries. The tendency for trade through intermediaries is observed in the markets that are smaller and more difficult to access, but can be also determined by the small size of the company and need for outsourcing the procurement function to intermediaries. Additionally, the intermediaries are also used when specific product characterises are required. Tang and Zhang (2012) shows the role intermediary plays in quality assurance and cost reduction. However, cases were found where an intermediary compromised on quality assurance resulting in delays and inconvenience for manufacturers (Abel-Koch, 2013). The author suggests that intermediaries perform a specifically important role in searching new customers and distribution channels abroad (Abel-Koch, 2013).

It was found that term wholesaler can be also used in association to firms who buy and sell goods at profit without making any modifications to the product, but there is still difference with many of modern intermediary trading firms. The description of main economic activities of wholesalers by the domestic governments (eg. US government – North American Industry Classification System (NAICS)) and international trade organisations (eg WTO) been found to be different. The US government distinguishes three business types – manufacturers, retailers and wholesalers. This leads to misleading information about the movement of goods inside the country and internationally (Ha-Brookshire and Dyer, 2008). Moreover, classification of intermediaries under one business type of wholesaler underestimates the importance of value adding activities such as design, branding, marketing and logistics, and creates ambiguity because of multiple meanings and perceptions. Intermediaries buy from the farmers when the farmers are ready to sell after the crop and sell to the processor when they wish to buy according to manufacturing needs. There are some large commodities' traders that occupy a large market share of the commodity market such as Glencore, Cargill, Trafigura, but there are also small trading houses that occupy the niche markets for the supply of specific types or grades of commodities or narrow range of products from small number of

countries (Blum et al., 2010; Fernandez-Bianco, 2012): “Import intermediaries specialize in countries, with, on average, 75 percent to 95 percent of imports coming from two countries. These intermediaries achieve scale by importing a small number of large volume HS6 codes; at the same time, intermediaries import a large total number of HS6 codes.” (Blum et al., 2010).

Geersbro and Vedel (2008) presented three variations in the intermediary types in the chain – adding value by representing the buyer, arranging distribution for suppliers or specialised middlemen creating value not only as a coordinator of logistics, but as “integrator of the buyer’s and supplier’s activities and communication in the value creation process” (p.3, Geersbro and Vedel, 2008).

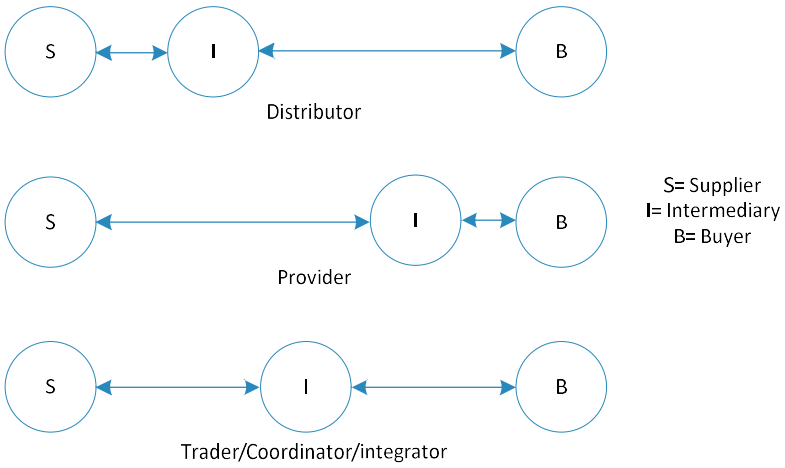

Figure 2.16 Three approaches to the intermediary in the supply chain (Geersbro and Vedel, 2008)

Intermediaries are concerned with three main decisions they need to make (Spulber, 1999):

1. Products/grades/qualities to purchase from suppliers
2. Types of suppliers to contract with
3. Allocation of goods and services for their customers

Two types of intermediaries are identified – ‘market maker’ or transactional intermediary, and ‘broker’ – informational intermediary. The former is holding inventory and taking the title of goods, and the latter is providing service without owning the goods (Wu, 2004). Types of

sourcing intermediaries have been further discussed by Vedel and Ellegaard (2013) as sourcing agent, import intermediary and international trader.

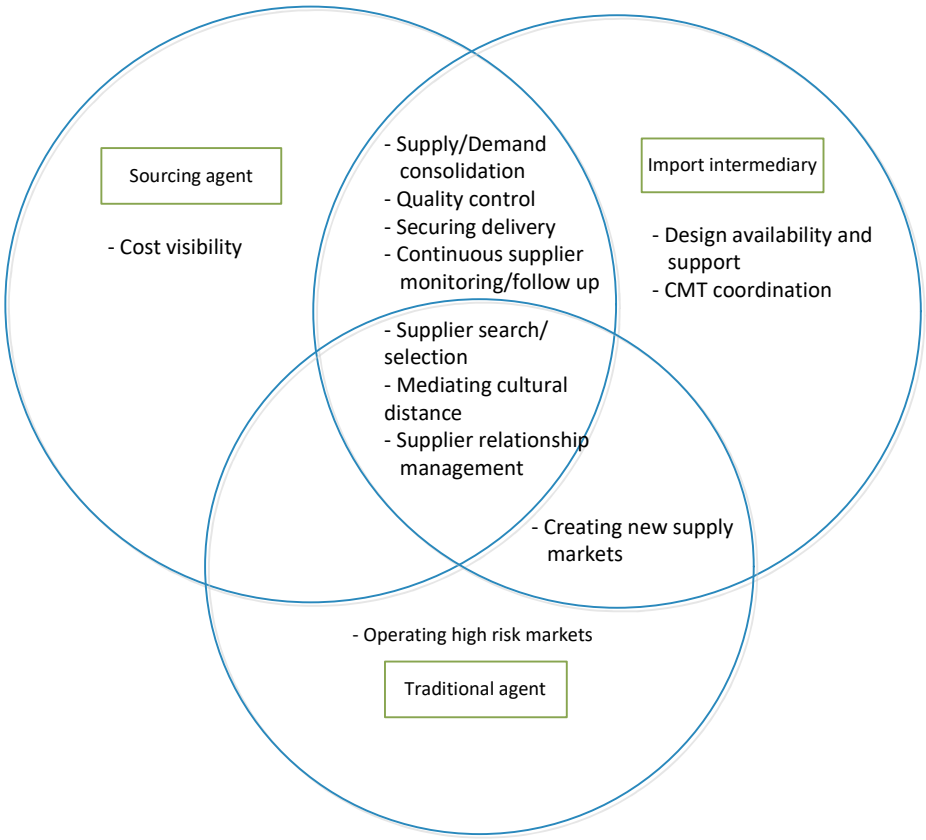

Figure 2.17 Types of sourcing intermediaries based on performed supply risk management functions (Vedel and Ellegaard 2013)

Intermediary trading companies, which take the title of goods and hold inventory in commodity supply chains are central to this research. The intermediaries in this research are classified as transaction intermediaries, however, they can have features from different types of intermediaries in different situations.

2.4.2 Intermediaries in Commodity Supply Chains

Sourcing and trade intermediaries are commonly used in commodity supply chains of different types and characteristics. Commodity supply chains are characterised by low cost products and low profit margins, which require the sourcing strategy to focus on products at the lowest possible price to stay competitive. Moreover, producing and importing companies

are required to adapt to ever changing trade restrictions, exchange rates, and transportation costs (Belavina et al., 2010). The need to retain flexibility while minimising the costs is the main reason for the presence of trade intermediaries in commodity supply chains. Table 2.4 identifies some of the largest commodity trading intermediaries operating globally.

Table 2.4 Major commodities' traders and commodities traded (Gibbon, 2014)

TRADING COMPANIES	HEADQUARTERS	COMMODITIES TRADED
VITOL GROUP	Geneva, Switzerland	Crude oil, coal, metal, sugar, gasoline, naphtha, natural gas, coal, power, iron ore, alumina, carbon, grains and oilseeds
GLENCORE PLC	Baar, Switzerland	Copper, zinc/lead, nickel, ferroalloys, alumina/aluminium, iron ore, coal and oil, grains, oils/oilseeds, cotton and sugar
CARGILL	Wayzata, Minnesota	Animal feeds, grains and oilseeds, biofuel, sugar, cotton, natural gas, oil products, petrochemicals, iron ore, steel
KOCH INDUSTRIES INC.	Wichita, Kansas	Oil
ADM	Decatur, Illinois	Corn, oilseeds, wheat and cocoa
GUNVOR GROUP LTD	Geneva, Switzerland	Crude oil, natural gas, liquefied natural gas (LNG), biofuels, power and carbon emissions, Copper, Aluminium, Zinc, Lead, Tin, Nickel and Manganese (in refined and raw materials), Steel, precious metal, coal, iron ore.
TRAFIGURA	Geneva, Switzerland	Crude oil, gasoline, fuel oil, naphtha, LPG, LNG, Biodiesel, Ethanol, coal, iron ore, refined metals
MERCURIA ENERGY GROUP	Geneva, Switzerland	Crude oil, fuel oil, middle distillate, gasoline, naphtha, petrochemicals, biofuels, natural gas, LNG, coal, iron ore, grains and oilseeds, carbon, copper, aluminium, lead, zinc, nickel
NOBLE GROUP	Hong Kong, Hong Kong	Grains and oilseeds, sugar, cocoa, cotton, coffee, coal, carbon complex, gas, power, polymers, iron ore, aluminium, bauxite, alumina, copper, zinc, lead, tin, nickel
LOUIS DREYFUS	Paris, France	Sugarcane, palm, oranges, lemons, grains and oilseeds, cotton
BUNGE	White Plains, New York	Grains and oilseeds, sugar, ethanol

WILMAR INTERNATIONAL	Singapore	Palm, grains and oilseeds, sugar, oleochemical, biodiesel
MABANAFT	Singapore	Petroleum
OLAM	Singapore	Cocoa, cotton, coffee, timber, diary, grains and oilseeds, palm, wool, rubber, wood
HIN LEONG	Singapore	Mogas, naphtha, gasoil, jet fuel, bitumen, base oil, petrochemicals, MGO, biofuel
ECOM	Switzerland	Cocoa, coffee, cotton, sugar

Belavina and Girotra (2012) provided the foundation for the use of intermediaries and showed that they facilitate dynamic changes in the supplier base to meet buyer specific requirements such as the quality or quantity of commodities. The role of trading companies as coordinators of supply chains has been further reviewed by Arya et al. (2015) who showed that even when intermediaries do not have unique sets of skills or information they still improve coordination of misaligned supply chains. Work by Qu et al. (2015) showed that an intermediary as an additional link in a supply chain is profitable when demand volatility is high, which is common for commodity supply chains. This research strongly supports the role of the trading companies that allow for better flexibility and efficiency in supply chains.

Two special characteristics of procurement and distribution of commodities differentiate them from other goods. First of all, the spot market often allows for higher flexibility in procurement and secondly, trading of futures contracts provides important price information that is used for forecasting and planning (Goel et al., 2011). These market options are then used as price estimates, which evolve randomly and spread between spot and futures prices. Goel's research (2011) interconnects fields of operations and finance and attempts to show how financial market information for commodities can be used to support operational decisions such as storage and distribution of commodities. Overall, they provide a valuation methodology for commodity trading operations in the presence of financial markets. However, Secomandi (2012) highlights the importance of correct valuation modelling for hedge calculations in order to provide reliable information for decision-making. Such valuation models assist commodity traders in making decisions in regards to buying and selling commodities based on the costs and available storage and shipping capacity (Goel et

al., 2011, Merener et al., 2015). Mark-to-market report is one of valuation techniques. The report breaks the position by origin/grades of commodities allowing to increase value because of higher/lower grades than those traded on futures market and add adjustments for costs involved and then compare the new value to the current price of the next futures month (see Appendix 19). The valuation models used in the research mentioned are not however able to take into account additional information about the current situation about the markets. However, Ahumada and Villalobos (2009) suggest that there is a need for models that incorporate more realistic features, such as uncertain information, logistics integration, risk modelling, regulatory environment, quality and security of products.

Chen et al. (2013) suggest that companies in upstream supply chains have to activate and coordinate resources and activities of other participants of the supply chain in order to effectively manage their supply chains. “In the apparel industry, intermediaries act as supply chain managers, buffering dynamic downstream customer environments by decomposing and reconfiguring upstream supply management functions” (Chen et al., 2013).

Intermediary in Cotton Supply Chains

The role of intermediaries in cotton supply chains have been reviewed several times in the literature. Popp (2000) proposed a theoretic framework to explain intermediation and focus his research on the role of intermediaries in clothing supply chains ‘as specialists in handling information’. The author argues that the supply chain concept was not able to explain intermediation, which is present in the majority of apparel supply chains. He continues to say that there were incompatibilities between intermediation and the supply chain concept in the way intermediation introduces information asymmetry into supply chain buyer-supplier relationships and claims that intermediation introduces additional non value-adding costs. The research focuses on the intermediaries that are ‘pure information specialists’ such as import and export agencies, freelance agents and brand owners leaving out intermediaries that take on the title of goods and having more value adding features to the supply chain. That case study illustrated how intermediation can reduce information cost caused by distance and volatility at the same time as improving supply chain transparency.

Chen and Fung (2013) investigated the types of relationships the intermediaries build with partners in the apparel supply chain. The implications of those relationships were reviewed. They found three relationship configurations:

1. Moderately dependent relationships with suppliers and customers and moderate flexibility upstream
2. Highly dependent relationships with suppliers and customers but low flexibility upstream
3. Relationships with suppliers and customers that are low in dependence.

The investigation showed that firms that maintained low dependence with suppliers and customers performed the worst, whilst even some dependence with customers and suppliers showed performance improvement (Chen and Fung, 2013).

Research is also undertaken to identify the role of sourcing intermediaries in managing supply risks. Vedel and Ellegaard (2013) conducted an explorative qualitative study with sourcing intermediaries, retailers and brand marketers. Their findings confirm that a "persistent and valued" actor in global supply chains is used to help manage supply risks.

Intermediary in Rubber Supply Chains

The literature on rubber supply chains highlighted several issues. Barlow (1997) reviewed the case of rubber estates and smallholders, adjusting their production activities such as labour, land and capital prices using new technologies and taking advantage of more integrated markets, better infrastructure and exploring export opportunities. The author found that difficulties arise with input trade and technology improvements for smallholders; but he also found that vertical linkages between smallholders and estates positively impact economic performance. Moreover, it's been highlighted that government micro-investments into infrastructure should help smallholders overcome difficulties with input markets. The study by Arifin (2005) is looking at the rubber pricing that would ensure high production standards and sustainable return to rubber producers. The marketing system of natural rubber has been reviewed showing that there is a number of intermediary participants that help move commodities from the village to the export. The roles of sub-district middlemen are critical in moving goods from villages to cities and trader-brokers are crucial in moving goods to crumb-

rubber factories. Another aspect discussed in the paper is links between rubber promotion and positive environmental and social benefits. More recent research papers by Marinim et al (2014) and Rukmayadi et al. (2016) were looking into sustainability aspects of green productivity improvements and green logistics in rubber supply chains. Additionally, Marimin et al. (2013) provided an example of a decision support systems application used by different supply chain participants for green supply chain applications. In this research we will provide an analysis of the application of information systems (decision support system) by intermediary trader/broker for performance improvement.

Intermediary in Coffee Supply Chains

The participants of the coffee supply chains include coffee growers, processors, traders/exporters, roasters and retailers. A lot of farmers in developing countries are still in disadvantaged position and are not aware of global trends, Fairtrade coffee, international pricing mechanisms, trade barriers or export regulations. The coffee traders should communicate with suppliers on demand fluctuations to increase the production of specialty coffee (www.ico.org). The study by the Institute of Developmental Studies (1994) showed that dealers or traders do not account for a large proportion of the cost of coffee and adding 8% to the overall price of q kilogram of beans (see Fig 2.6). In the meantime, the coffee roaster receives some of the largest portions of the final price on coffee. The roaster navigates between various traders to get the best price on coffee and blend different types of coffees so that customer might not be fully aware of the coffee beans that went into that blend. There was no follow up study to update or confirm the findings, and numerous changes happened in the supply chains, including trader's increasing margins reductions.

The previous research in coffee supply chains also concerned the political economy in coffee supply chains (Talbot, 2004; Lukanima and Swaray, 2014), coffee marketing and distribution (Catturani et al., 2008), the impact of internet-enabled technologies on coffee prices (Banker et al., 2011; Donnet et al., 2011); governance (Carvalho et al., 2016; Duhamel et al., 2016) and the sustainability aspects of coffee chains (Astuti et al., 2015).

2.4.3 Intermediaries' Role in Information Flow Management

Information is a critical resource in the knowledge economy and global market (Nor, 2011). Casson (1997, in Popp, 2000) describes the role of intermediaries in handling the information flows. Intermediaries are able to economise on information flow costs because they act as hub between buyer and supplier by gaining economies of scale, scope and learning. Using information, intermediaries are able to integrate 'markets over space and time', adding value by improving co-ordination. The commodity trading environment is often described as low trust which in turn means that sharing of competitive information and infrastructure is limited (Callado and Jack, 2015). Understanding of the current state of relationships between counterparties in upstream supply chains will help better understand the dynamics of their interactions.

Ellis (2010) reviewed the factors influencing the introduction of marketing skills into developing economies by international trade intermediaries focusing on knowledge transfer. The need to use technology to best manage coordination of different 'pieces of the chain' and improve efficiency was recognised (Ellis, 2003 in Fung et al., 2007). The author provides an example of a trader exercising its power to keep its client dependent in cases where the role of intermediary traders can decrease as the suppliers from developing countries learn the skills necessary to conduct trade themselves. The author is concerned with the circumstances which enhance the intermediary's ability and incentive to help developing countries and found that intermediaries play a positive role in knowledge transfer and that governmental support is required to encourage competition among intermediaries (Ellis, 2010). Intermediaries are recognised to improve communication between buyers and sellers by improving the flow of information along the supply chain. The relationship with suppliers has shifted to developing co-operative interactions to improve information exchange about the market and product. Specific attention is given to the willingness of suppliers and buyers to be flexible in quantity, qualities or delivery schedules in response to changing requirements of the partner (Fung et al., 2007).

2.4.4 Functions of Intermediary Commodity Trading Companies

Ensuring regular volumes and quality of goods delivered at the right time and price is a driving force in commodity markets and value added by the intermediary organisations (Bryceson, 2010). The examples of the functions of intermediary organisations are presented in Table 2.5.

Table 2.5 Functions of intermediaries

TYPE OF INTERMEDIARY	FUNCTIONS	AUTHOR
ECONOMIC INTERMEDIARY	1. Setting prices and clearing markets 2. Providing liquidity and intermediacy 3. Coordinating buyers and sellers 4. Guaranteeing quality and monitoring performance	Spulber (1999)
TRANSACTIONAL INTERMEDIARY	1. Reducing uncertainty by setting and stabilising prices 2. Reducing costs associated with searching and matching 3. Providing immediacy by holding inventory or serving capacity 4. Aggregating supply and demand to achieve economy of scale	Wu (2004)
INFORMATIONAL INTERMEDIARY	1. Avoiding adverse selection by administrating coordination mechanisms 2. Creating a trusted institution thereby reducing the needs for direct negotiation, thus transaction overhead 3. Synthesising dispersed information to reduce information asymmetry	Wu (2004)
TRADER	1. Demand forecasting 2. New product development 3. Brand and category management 4. Marketing 5. Promotions generation and management	Adebanjo (2009)
EXPORT INTERMEDIARY	1. Market research, finding overseas buyers, distributors or commission representatives 2. Product research and design 3. Negotiating collaborative agreements on behalf of suppliers 4. Advertising 5. Shipping	Balabanis (2000); Peng and York (2001); Nor (2011); Suwannarat and Suwannarat (2016)

	6. Warehousing 7. Quality control of export goods 8. Financing and credit 9. Exhibition products and services 10. Arranging documentation 11. Competence to reduce clients' transaction costs	
SOURCING INTERMEDIARIES	1. Ability to lock in required supplier capacity for orders 2. Quality assurance 3. Timely delivery of orders 4. Ensurance for compliance with environmental and social norms	Vedel and Ellegaard (2013)
TRADE FACILITATION	1. Physical infrastructure – deliveries, storage, etc. 2. Administrative processes – customs, borders, tariffs, documentation, application of trade laws and regulations 3. Use of information and communication technologies to harmonize and standardise trade procedures	Turnes et al. (2015)
INTERMEDIARY	1. Sourcing 2. Supplier quality control 3. Shipping management 4. Distribution	Fung et al. (2007)

There is no single definition of the set of functions executed by the intermediaries in the supply chains and depend on the specialisation and market environment of the intermediary. The core task for intermediaries in this research is generic in order to address various types of upstream supply chain intermediaries - facilitation in flow of materials, information and resources along the supply chain.

2.4.5 Relational View of Intermediation

The key competency of intermediary organisations is efficient synchronisation of upstream and downstream supply chains in order to ensure that manufacturing cycles match forecasted demand, improve supply chain processes and organisational confidence in partners (Adebanjo, 2009). Managing networks of supplier and customers allows intermediaries to access the information about market and organisations (Chen et al., 2013). Supply chain management research is suggesting that closer relationships and integration with suppliers and customers improves supply chain effectiveness (Gunasekaran et al., 2004; Aramyan et al., 2006; de Haan, 2016).

The research on supplier-intermediary-customer relationships is very limited, the work to date have been done on dyadic buyer-supplier relationships (Leonidou, 2003; Fung et al., 2007; Oxborrow and Brindley, 2014). Leonidou (2003) highlights that the international trade of goods involves numerous behavioural interactions between partners including information and social exchange at the same time as the actual transaction of goods. Moreover, a relational view of international trade is important because buyers and suppliers are mutually dependent on each other in terms of resources, knowledge and expertise. Leonidou (2003) in his work reviews relationship characteristics during four stages – engagement, initiation, development and sustainment. The role of 'indirect hints on initiating foreign customer relationship' including intermediary agents and traders should be further reviewed in regards to partner selection, roles and responsibilities assumed in new relationships, bargaining power in relationships on pricing and product selection, degree of dependence and interest in investing into relationships, and the nature of exchanges such as information, social, and the services that will take place in the relationship (Leonidou, 2003).

Fung et al. (2007) conducted a study to examine the impact of relationship coordination on the performance of trade intermediaries. The relationships with foreign partners are more complex, dynamic and difficult to maintain because companies in the supply chains are located in different countries and often pursue different goals. At the same time, coordinated relationships and activities between different participants within a supply chain is a critical factor for high performance (Fung et al., 2007). Their results show that the flexibility in buyer-supplier relationships and internal business operations that are focused on sustaining

relationships with customers contribute significantly to the performance of trade intermediaries.

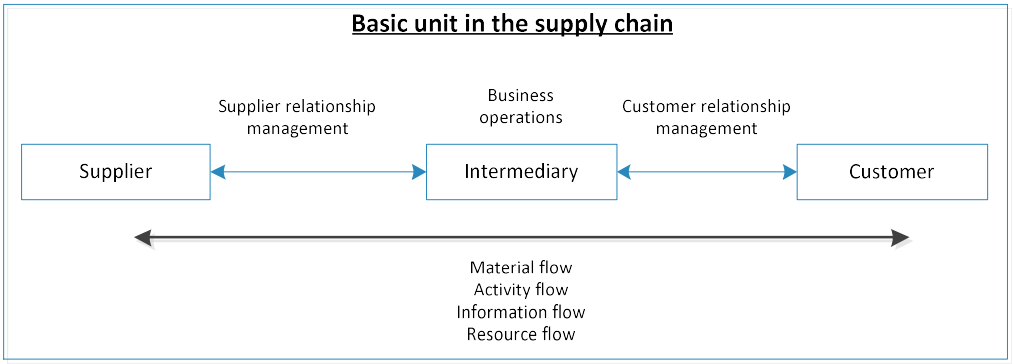

Figure 2.18 Basic units in the supply chain (Fung et al., 2007)

Duhamel et al. (2016) examined relations and strategies within coffee supply chains focusing on identification of how information sharing can be implemented to improve the relations within the supply chain. To develop effective sharing standards, stakeholders of the SC should be highly engaged in the process. Their study investigates potential conflicts that can arise during the process of the creation of certain information-sharing platforms as well as points out conditions needed to escape the conflicts altogether. The study identifies five distinct types of supply chains in terms of exhibited values: "civic- industrial (the 'traditional fair trade' supply chain), industrial-civic (the 'type I mixed' supply chain), industrial-market (the 'type II mixed' supply chain), industrial- domestic (the specialty coffee or relational supply chain), and the domestic- industrial (the 'medium-sized famer' supply chain)" (p. 142, Duhamel et al., 2016). Due to the varying nature of all these types, a multitude of different arrangements is possible, which may or may not spur conflicts because of opposing goals or interests. For instance, in an industrial-civic supply chain, leading players such as Nestle regulate quality standards thus shaping the process of labour distribution along the chain. An industrial-market supply chain has conflicts with strategies of fair trade due to omitting additional costs from external production or distribution processes. In contrast to stringent certification standards of traditional suppliers, specialty coffee supply chains rely more on a personal relationship model between supply chain participants.

Findings of that study suggest that an ongoing compromise is direly needed within and between different types of supply chains to create higher incentives for employing information-sharing platforms. Public administration should step in with more welcoming and favourable conditions for milder certification standards, which would showcase the advantages of information sharing. Once this approach becomes adopted, the companies will overcome the obstacles created by mistrust.

The aspects of trust and power have been previously discussed in regards to intermediaries in the supply chains. Quark (2013) described the power of cotton traders in negotiating global contract rules and efforts for standardisation, and Chen et al. (2016) showed the power of supply chain orchestrators on the other supply chain participants. Issues of power, trust and dependency arise from information asymmetries in the supply chains. Developing close relationships with supply chain partners help intermediaries manage risks and reduce supplier opportunism. They cultivate personal relationships based on trust over time and maintain frequent interactions (Vedel et al., 2013).

2.4.6 Intermediaries' Risk Management

The operations of commodity trading companies in upstream supply chains are complex and high-risk. The merchants' operations involve "valuing and buying commodity conversion assets (or leasing their capacity) and then using an operating policy to maximise their real option value by trading the underlying physical input and output commodities" (Secomandi, 2012). In essence, intermediaries are taking on risks associated with physical transportation and storage of goods as well as risks of changes in value of goods during that period or supplier underperformance. Moreover, the risks within upstream supply chains arise from weaknesses of inter-connected flows of goods, information and finances (Bode and Wagner, 2015). The development of company policies for risk management in supply chains is essential for every day operations.

Risk management is a formal process that involves "identifying potential losses, understanding the likelihood of potential losses, and assigning significance to these losses" (p. 699, Giunipero et al., 2004). Risk is also defined as "any form of disruption in the

information, product or material flows from the original supplier to the end consumer" (p. 7, Juettner et al., 2003). Supply chain management aims to reduce these risks and improve competitive performance by integrating internal operations with the operations of external suppliers and customers. Among other things, the research efforts in supply chain risk management practices focused on:

1. Risk assessment (Christopher et al., 2011; Zsidisin et al., 2012; Erikson et al., 2014; Septiani et al., 2016)
2. Proactive risk management practices and forecasting (Tang, 2005; Trkman and McCormack, 2009; Gao, 2014)
3. Managerial perceptions of risk (Zsidisin, 2012)
4. Management's decision making in the environment of uncertainty (Cantor et al., 2014)
5. Impact on performance (Hoffman et al., 2013)
6. Collaboration and integration practices for supply chain risk management (Ali and Shukran, 2016; Wiengarten et al., 2016)

Zsidisin (2012) provided a classification of various factors that affect the purchasing and supply management's perception of supply risk. Supply risks are derived from the following three main categories: item characteristics, market characteristics and supply characteristics. The understanding of supply risks is crucial for a supplier's long-term success. However, risks are, and should be, prioritised differently based on which industry a supplier is targeting and what type of product is being offered to the consumer. For instance, a supplier of electronic chips might itself be a second-tier supplier, which is heavily dependent on the third-tier suppliers that mine and ship silicon from Asian countries such as Thailand. Currency fluctuations, economic instability in the country as well as location of seismic instability all are examples of market category supply risks, which if underestimated by the lower tier suppliers might heavily affect their product release and delivery timelines. Therefore, even though it is critical for the second-tier supplier to prioritise supply risks characteristics such as more predictable time cycles, flexibility and scalability, global market influence cannot be underestimated, especially when working with suppliers overseas. An inability to do so would pose a risk for this supplier in terms of timely product shipment and proper quality assurance.

Juettner et al. (2003) insisting that successful risk management practices require better focus on actual decision making and supply risk causes, risk drivers and mitigation strategies. The sequence of consecutive actions is identified:

1) Assessing the sources of the risk;
2) Identifying the risk concept of the supply chain by defining the most relevant risk consequences;
3) Tracking the risk drivers in the supply chain strategy;
4) Mitigating risks in the supply chain.

As for risk management research in commodity supply chains, Septiani et al. (2016) focused on identifying and assessing risks that occur in supply chains in the agricultural sector. As the supply chain becomes more extensive due to ongoing globalisation, the path from gathering crops to delivering final product takes longer, which creates specific risks attributable to perishable products. Some of the specific risks include the impact of viruses, pathogenic bacteria or fungi in the food chain that might further influence human health. Strict inspections and preservation techniques have to be constantly applied to keep the agricultural products fresh and free of pathogens. Five criteria of supply chain risks were taken into consideration: “macro level risk, demand management risks, supply management risks, product/service management risks and information management risks” (p. 60). The authors stressed the need for responsible and meticulous development of food supply chain risk models, since this will help to ensure the safety and freshness of the food products from their origin (farms) through to suppliers and any processing facilities to the destination (end consumer).

Hoffman et al. (2013) have reviewed the impact of risk management practices on performance. Their findings indicate environmental and behavioural uncertainty have a negative effect on supply risk management performance. In addition, supply risk mitigation and supply risk management process maturity positively influence supply risk management performance, the latter having the strongest influence. Furthermore, supply risk monitoring, supply risk mitigation and supply risk management process maturity all moderate the effect of environmental uncertainty, whereas only risk monitoring has an influence on the relationship between behavioural uncertainty and supply risk management performance.

A cotton trading guide developed by the International Trade Centre (2007) has identified the key risks in cotton trading as: price risk (including outright price and price with respect to futures), credit risk, documentation risk, counterparty risk (mainly in regard to unshipped sale or purchase contracts), and currency risk. Supply chain risk management is mainly concerned with identification of potential risks and implementation of risk management procedures to decrease the occurrence of those risks in their supply chain (Hong and Lee, 2013). The trading intermediary organisations are required to continually adjust to the changing market and global environment in order to perform according to contracted terms with the partners and comply with international trade regulations (REMIT, EMIR and EMIR phase 2, Dodd-Frank, MAS, etc.). It is a critical objective for the intermediaries to develop and maintain their unique resources that help their customers to minimise risks and costs (Peng and York, 2001). These resources are often intangible and knowledge-based such as market knowledge.

Types of Commodity Supply Chain Risks

Four main risk management areas in intermediary trade were identified and will be further reviewed:

1. Financial risks

First of all commodity trading firms are concerned with their financial performance and the risks associated with high prices and market volatility. Managing price changes at different stages of the process is a complex multi-functional task. Intermediary companies have developed some sophisticated risk management tools such as hedging on financial markets. Financial commodity markets are used as safeguards against price fluctuations. The hedging mechanism is explained as making a futures transaction – buying or selling futures contracts in order to offset the actual deal (Berne Declaration, 2011; Secomandi, 2012; Gao, 2014).

Valuation models are used for risk assessment and dynamic hedging (Secomandi, 2012). However, valuation models are only effective if tailored to company needs and use appropriate calculations. Two issues have been highlighted with regards to goods valuations – incorrect valuations of commodity assets can lead to errors in price strategy; and secondly,

hedging model error can cause the disruptions of the operations due to incorrect cash flow analysis (Secomandi, 2012).

2. Operational risks

The operational risks in intermediary commodity trade include cost, on-time deliveries and storage of commodities. Moreover, documentation and information management are extremely important for effective turnaround and the risks of error in documentation and missed information need to be addressed. The risks associated with shipment of goods and inventory holding are successfully managed by intermediaries because of scale which is cultivated and maintained by large number of suppliers and customers (Vedel et al., 2013).

3. Stakeholder risks

Stakeholder risk management is another important aspect in commodity trade. Many researchers have been considering supplier assessment, selection and purchasing decisions (Trkman and McCormack, 2009; Jaffee et al., 2010; Garcia et al., 2013; Eriksson et al., 2014). Trkman and McCormack (2009) discussed supply chain network risk and provided an approach for assessment and classification of suppliers by their attributes, performances, and supply chain characteristics. This approach is supposed to enable companies to make more informed decisions as to how much risk they are willing to take and what risks to mitigate.

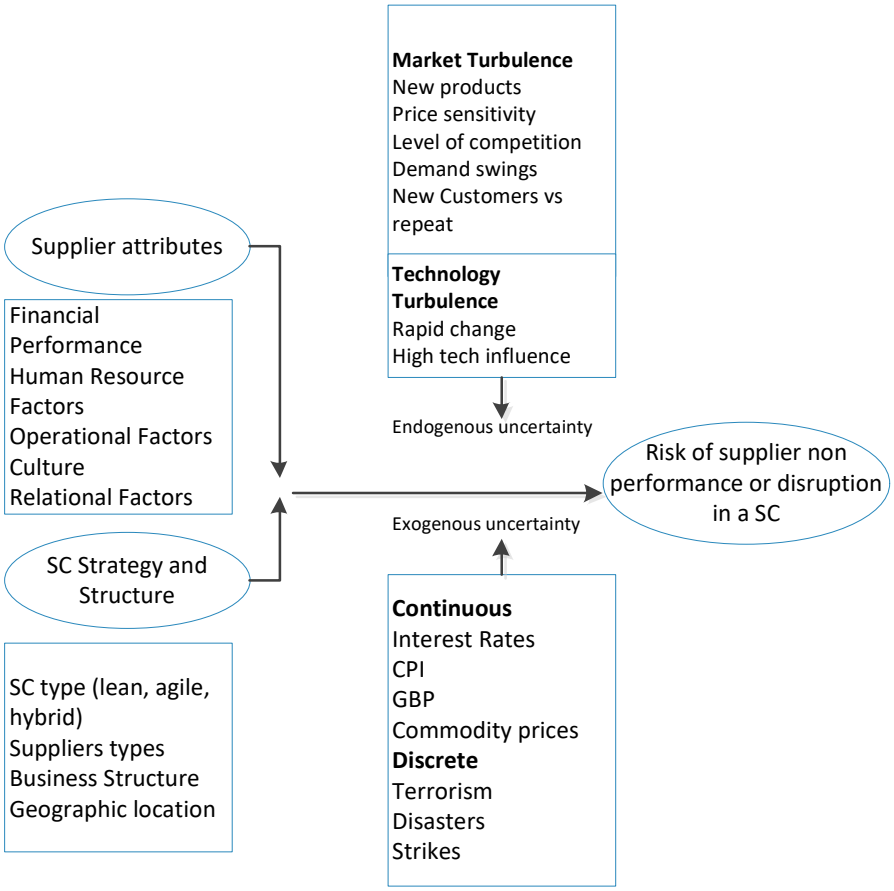

Figure 2.19 Conceptual model for supplier's attributes and performance assessment (Trkman and McCormack, 2009)

Other research efforts related to the supply chain partners have been undertaken in order to review sustainability risks (Hussain et al., 2005; Wahl and Bull, 2014; Hajmohammad and Vachon, 2016). To manage their risks, intermediaries can monitor and check on the supplier performance due to their local knowledge or presence. Intermediaries are able to spot suppliers compliance with Corporate Social Responsibility and sustainability principles to reduce costs. Hajmohammad and Vachon (2016) in "Managing supplier sustainability risk" consider various strategies for supply risk management, such as acceptance, mitigation (collaborative or monitoring) and avoidance. In practice there seems to be no clear advantage of one strategy over the other as companies, even within the same industry, often employ more than one, depending on the context of the situation and the nature of their product and policy. The focus is being made on supplier sustainability risk, which is not to be confused with

the notion of ‘pure risk’. Pure risk or supply chain disruption risk is attributed to unexpected events that disrupt supplier’s nominal working process, such as natural disasters, strikes, market crashes. In contrast, supplier sustainability risk is linked to ‘adverse stakeholder reaction’ (p. 50, Hajmohammad and Vachon, 2016). When the lower level of risk is assessed by managers, they tend to prefer monitoring-based mitigation strategy, whereas higher levels of risk usually steers managers towards collaborative type strategies. Since most risk management decisions are based on personal judgement, it is critical to provide the responsible personnel with enough data about research and key concepts to help them form more appropriate decisions down the line. Among strategies, the case studies found clear distinction in a managers’ propensity towards either collaboration-based or monitoring-based risk mitigation strategies. Risk avoidance and acceptance strategies were also taken into consideration during the study.

4. Other risks

Bonanomi et al. (2016) explored the dynamics of the Swiss commodity sector starting from 2002 till the present day. The ongoing globalisation put immense pressures on Swiss commodity markets to stay competitive. The research base in this field is quite scarce as there is not enough data for cross-border and transit activities to facilitate the decision making in terms of developing risk management strategies. Since Switzerland has very little to no natural resources, commodity trading became one of its primary economic drivers. As such, it became crucial to closely monitor and prevent any possible risks that could disrupt the functioning of the commodity trading sector. As the goods are imported from resource-rich countries, the research has been done on their social and political standings. It turned out that as a rule, issues such as corruption, violation of human rights, mispricing, high levels of social inequality, tax avoidance are more relevant to resource-rich countries, i.e. exporters. These factors contribute to the overall volatility and instability in the commodity supply chain. For instance, most soft commodities like coffee, cocoa, and rubber are being exported from poor African countries, where social instability and human right violations are significant. In Côte d'Ivoire, one of the largest cocoa exporters, the practice of child labour is widely used and has come underground avoiding international regulations. Even though child labour is illegal, it nevertheless increases the overall cocoa production rate, increasing the farmer’s

income and satisfying growing market demand. To combat this and other similar violation problems, significant resources need to be allocated to local communities to increase awareness and thus reduce the occurrence of such violations. The adverse effect of this, however, will be the reduction in production rates, to which the suppliers and the buyers have to be prepared beforehand. The priorities in risk management strategies have to be outlined to either prioritise the exporter country's social stability thereby sacrificing commodity import rates, or try to increase the import rates, potentially contributing to greater abuse and social instability, since profit and production rates at local sites gain higher value than human well-being. This is, however, just one example of one aspect among the plethora of risks that can affect the supply chain functionality. Some of the solutions to mitigate the commodity market risks through reducing their effect or eliminating some of them altogether include, but are not limited to, higher collaboration between countries, more transparent trading practices, implementation of more environmentally friendly solutions, and monitoring the adherence to regulations on site such as labour conditions (Bonanomi et al., 2016).

Cantor et al. (2014) highlights the impact of human factors in supply chain risk management: "Even though many firms have developed contingency plans to address potential points of vulnerability, it is the firm's supply chain employees who, often without much warning, must make decisions on how to best react, or not react, to potential supply chain risks or supply chain disruptions" (p. 163, Cantor et al., 2014). Moreover, complexity and uncertainty of commodity supply chains contribute to difficulties in decision making for the supply chain operators. The authors conclude that firms should assist managers with conducting risk assessments – enforcing a company lead risk management strategy measuring cost-benefit trade-offs of mitigating actions.

2.4.7 Intermediaries' Impact on Supply Chain Performance

Peng and York (2001) proposed that export intermediaries' performance relies on their possession of "valuable, unique, and hard-to-imitate resources which help minimize their clients' transaction and agency costs" (p. 327, Peng and York, 2001). Three types of costs have been identified – client's search costs, client's negotiation costs and client's monitoring/enforcement costs. An intermediary's performance relies on both its ability to

provide efficient knowledge-based search and negotiation services, and behavioural-based signals they send to exporters. Behavioural-based signals should help an exporter identify "honest and capable intermediaries from those who are likely to be opportunistic and incapable" (p.340, Peng and York, 2001). Popp (2000) showed how an intermediary can lower the information costs caused by distance and volatility and improving supply chain transparency. Nor (2011) suggests that the performance of export intermediaries is based on market coverage and geographical distance. The author advises the importance of firm competences such as technology, export/market knowledge, management attitude and customer relationships in export intermediary performance.

Suwannarat and Suwannarat (2016) explored the direct and indirect impact of three intangible resources – export knowledge, negotiation skills and specialisation and trustworthiness on export intermediary performance by assessing their competency to reduce clients' transaction costs. The export knowledge is reducing companies' search costs; negotiation skills are reducing negotiation costs that can be reflected in risks of dealing with new partners as well as actual costs associated with travel, communication and staff; specialisation and trustworthiness are minimising costs for monitoring and enforcement of contractual obligations.

In the supply chains, intermediaries may impact the performance of exporters by allowing suppliers to reach a wider range of foreign markets. Adebanjo (2009) suggests that intermediaries improve efficiency in the food supply chains by:

- Building collaborative relationships with retailers and putting pressure on them to provide more accurate and timely information;
- Increasing the number of suppliers for better supply chain flexibility and competition;
- Develop approaches to better management of promotions and forecasting to improve disproportions between upstream and downstream supply chains.

Analysis by Belavina et al. (2010) shows that using intermediaries for sourcing of goods reduces the supplier side incentive for "inefficient behaviour by limiting the immediate gains from such behaviour and by providing more long-term sourcing business in its absence" (p. 1, Belavina et al., 2010)

Some frameworks used for supply chain performance measurement as well as designated agricultural supply chains performance measurement frameworks will be further reviewed in section 2.5 of this chapter.

2.5 Supply Chain Management, Performance, and Underplaying Operations Management Theories

This section reviews various performance metrics and established performance measurement frameworks presented in the literature. The main focus is on the metrics that can be used in measuring performance in commodity supply chains. Secondly, subchapter reviews theories most commonly used in operations management research and defines the relational theory as underlying in this research.

2.5.1 Supply Chain Performance Measurement

The commodity supply chain management is driven by the need for value creation for customer, companies and their counterparties (Lambert, 2008). Various factors contribute to the performance and value created in upstream supply chains. The production of raw materials is directly affected by climate and weather changes which result in variable performance and supply of commodities season by season. Ensuring the regular volumes at scheduled times of high quality products regarded as key business consideration and requires comprehensive supply chain management (O'Keeffe, 1998; Dunne, 2001; Bryceson and Kandampully, 2004). Low profit margins and costs of productions and transportation of commodities increase the need for close performance monitoring by the companies (Boehlje, 1999; Ricketts and Rawlins, 2001, Bryceson, 2006). Supply chain management on a strategic level is focusing on transforming the way company processes meet the needs of customers whilst operations management is concentrating on the company functions such as sourcing, buying, manufacturing and distributing (duToit and Vlock, 2014). This work is reviewing the performance measurement approaches for both levels.

Measures are quantifiable metrics of expected results, which should be systematically tracked

to monitor progress (Bryceson and Slaughter, 2009). Specific metrics allow managers to translate an organisation's goals into more concrete and tangible terms (Melnyk et al., 2004). Companies measure things that are most important which indicates how they intend to deliver value to their customers. This means that the metrics should best represent the needs, characteristics and challenges of the specific supply chain (Melnyk et al., 2004).

A metric is "a verifiable measure, stated in either qualitative or quantitative terms and defined with respect to reference point" (p.211, Melnyk et al., 2004). Metrics allow to filter down large volumes of data and increase information richness. The critical elements of the measure include:

- Verifiability – based on agreed set of data and processes for translating data into measure
- Measurability – characteristics or outcomes are captured in numerical or nominal forms. The reference point like benchmarks should allow for comparison
- Meaningfulness – the measures should be expressed in meaningful terms
- Value-based metrics – metrics should be linked to how the operation delivers value to its customers and potentially other stakeholders in the chain

Since then, more interest into performance metrics in supply chains have been shown by Gunasekaran and Kobu (2007) who present a literature review of the metrics in logistics and operations management, Chen and Gong (2013) evaluate performance of supply chain networks, Kovach et al. (2015) look at performance measurement in dynamic environments, Paustian et al. (2015) addresses performance measurement for arable farming, and others (Piotrowicz and Cuthbertson, 2015; Dunn et al., 2006; Siham et al., 2015).

Measuring the performance of the commodity supply chains is more difficult due to the complexity of the supply chain (Bozarth et al., 2009), complicated decision making (Manuj and Sahin, 2011) and supply chain disruptions (Chopra and Sodhi, 2014; Craighead et al., 2007; Narasimhan and Talluri, 2009 in Bode and Wagner,2015). The performance metrics in these conditions should address capabilities to learn and adjust to the environment as well as understanding relational ties, social capital, resource access and collaboration (Bode and Wagner, 2015).

In commodity supply chains as in many other industries performance can be monitored on two levels – strategic and operational in line with the decision making (Sabri and Beamon, 2000). Strategic performance normally concerns a long time horizon and guide supply chain policies from design perspectives. Operational performance is short term and focuses on daily activities. Both levels are important to ensure effective and efficient management of logistics and product flow in the supply chain (Sabri and Beamon, 2000).

Thus far, several studies have investigated supply chain performance influencing factors. For instance, Carr and Pearson (1999) examined the performance outcomes of buyer-supplier relationships, Otter et al (2014) investigated the effect of relationships in networks on participant's performance. Numerous factors been highlighted with regards to performance – market developments, financial structures of the farms' internal operations, relationship with counterparties and reputation (Paustian et al. 2015). Different measures can be clustered into the following groups which are used in commodity supply chains:

- Logistics and inventory related measures
- Process related measures
- Financial measures
- Purchasing related measures
- IT related measures
- Other measures

Inventory management and inventory reduction are some of common measures for supply chain performance (Rabinovich, 2003; Straub, 2004; Shah and Shin, 2007; Mishra, 2013). When it comes to commodity trading, the goods are generally split into perishable and non-perishable which allows for long term storage or requires specific storage conditions and only for a limited time. The inventory levels are not stable and depend on market conditions and customer requirements. For instance, during periods of low market prices on coffee, traders can fill the warehouses and expect price rises in order to make a higher profit margin. On the other hand, it involves additional costs. Effective management of the stocks can be measured in financial terms and operational efficiency.

However, many performance measurement approaches were criticised for conflicting metrics

or monitoring only past activities advising that metrics should allow for forecasting into the future incorporating a way of measuring forecasting success and customer service (Merchant and Van der Stede, 2003; Harrison and Godsell, 2003 in Bryceson and Slaughter, 2009). Moreover, the companies tend to apply metrics by department whilst losing focus of overall goals (Bryceson, 2006). In addition to traditional financial, material and process performances companies should consider metrics that concern system resources and flexibility (Beamon 1999; Brycson, 2006). Furthermore, the lack of clarity on performance metrics approaches and difficulties defining supply chain metrics create barriers to successful implementation of performance measurement models (Theeranuphattana and Tang, 2007). The alignment of metrics to the company needs is another contributing factor to inefficiency and disruptions in supply chains.

Different frameworks and approaches have been proposed for measuring performance. They include Balanced Scorecard, SCOR, Activity-based Costing, as well as newer approaches of virtual games as learning environments where players could develop and implement business scenarios seeing the impact and effect of their decisions on various components of the supply chain (Bryceson, 2009). The following sub-section will review some of the frameworks commonly used in supply chain management.

2.5.1.1 *Balanced Scorecard*

The Balanced Scorecard (BSC) was developed by Kaplan and Norton in 1990s as a planning and management tool for twelve American companies. BSC has been proposed as a tool to monitor an organisation's performance against strategic goals (Cai et al., 2009). This framework added strategic and non-financial performance measures to traditional financial metrics in order to eliminate the weaknesses of accountancy-based measures and allow for a more 'balanced' view of company performance. Such non-financial performance measures include markets and customers, internal business process, learning and growth (Paustian et al., 2015). The Balanced scorecard is claimed to be a tool which can help link company strategy with its implementation into practice, all measures should be aligned to the company vision

and strategy. This approach is focusing on viewing a business from different perspectives and asking question in regards to:

- How do customers see us? (customer perspective)
- What must we excel at? (internal perspective)
- Can we continue to improve and create value? (learning and growth perspective)
- How do we deal with shareholders? (financial perspective) (Kaplan and Norton, 1992)

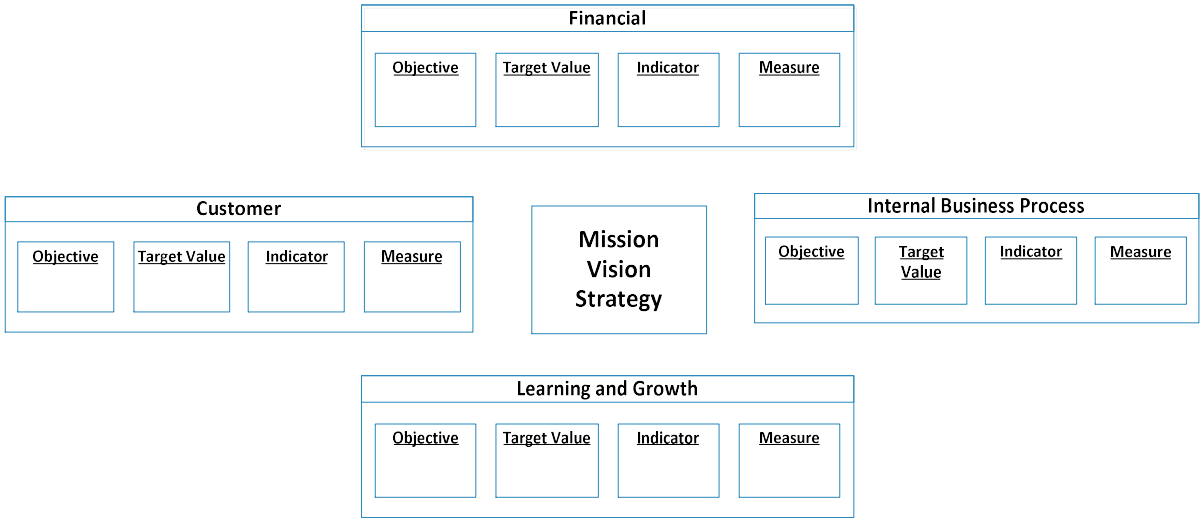

Figure 2.20 Balanced Scorecard Concept (Paustian et al., 2015)

This approach is believed to be of most benefit in allowing observing interrelationships between different business areas and how improvements in one area could affected other business areas (Dunn et al., 2006). This approach was not specifically developed for supply chain performance measurement, but considered useful and adopted as follows (Lapid, 2015):

- Customer perspective: on-time delivery and order fulfilment
- Internal Perspective: forecast errors, planning errors
- Learning and growth perspective: new product development lifecycle
- Financial perspective: cost of manufacturing and cost of warehousing

The approach was used by Haapasalo et al. (2006) to connect strategic management and operations performance measures. Strategic planning is primarily concerned with outcomes and results and how they can be accomplished. Whether qualitative or quantitative measures applied to measure future outcomes it should also define threshold criteria of success (Haapasalo et al., 2006). These critical success factors at a strategic level have to have clear connections to the business process and business drivers.

It has been suggested that the four perspectives proposed by the BSC are not equally important to different participants of the supply chains (Johanson et al., 2006). Callado and Jack (2015) adopt the same strategy to review different BSC metrics used for different roles in the supply chains. These variances are explained by different strategies employed by companies. This is due to the proposed links between performance indicators and company strategy.

Lissitsa (2005) criticised the framework for difficulties in selecting appropriate metrics for companies. Author emphasizes the lack of cause-effect relationships between the four major perspectives – the links between performance variables are found ambivalent such as relationship between customer satisfaction and financial success, statistical and lacking causality or in some cases non traceable. Another weakness of the BSC approach highlighted that having only four perspectives is not sufficient for performance measurement (Shadbolt, 2003; Lissitsa, 2005; Dunn et al., 2006) and should also take into account company features such as size, experience of personnel and employees commitment to the process, local condition and expectations for production (Bourne et al., 2003). This is explained by the BSC model originated from American business and large companies as a controlling mechanism and transformed afterwards (Haapsalo, 2006). Moreover, the assumption of hierarchical relationships among four major perspectives is also questioned and unidirectional relationship among measures are proposed (Lissitsa, 2005).

In the commodity supply chains, the BSC can provide a good basis for continuous performance monitoring over time, best and worst practices and fields for improvement as well provide guidance of the management decisions because this framework can be also viewed as management system (Lissitsa, 2005). The framework allows to identify differences between actual and desired performance, and develop strategies to address that gap. What is most important, it provides the combination of financial and non-financial indicators for different

participants to develop enterprise-specific strategies adjusted to the trading environment. However, using this metrics for assessing entire supply chain performance has been questioned because different companies might be using different sets of metrics to define their own BSC (Call, 2015).

2.5.1.2 *SCOR*

Another approach for measuring SC performance is the SCOR reference model (Bolstorff and Rosenbaum, 2003). It is a tool used to describe business activities associated with all phases of the supply chain process, using a set of activity building blocks. SCOR was adapted for value chains and defined as a macro process for marketing, design, supply and customer. The set of metrics used in SCOR includes:

- Cycle time metrics (production cycle time or cash to cycle)
- Cost metrics (cost per activity)
- Service/quality metrics (on time delivery, defects, returns)
- Asset metrics (inventory level)

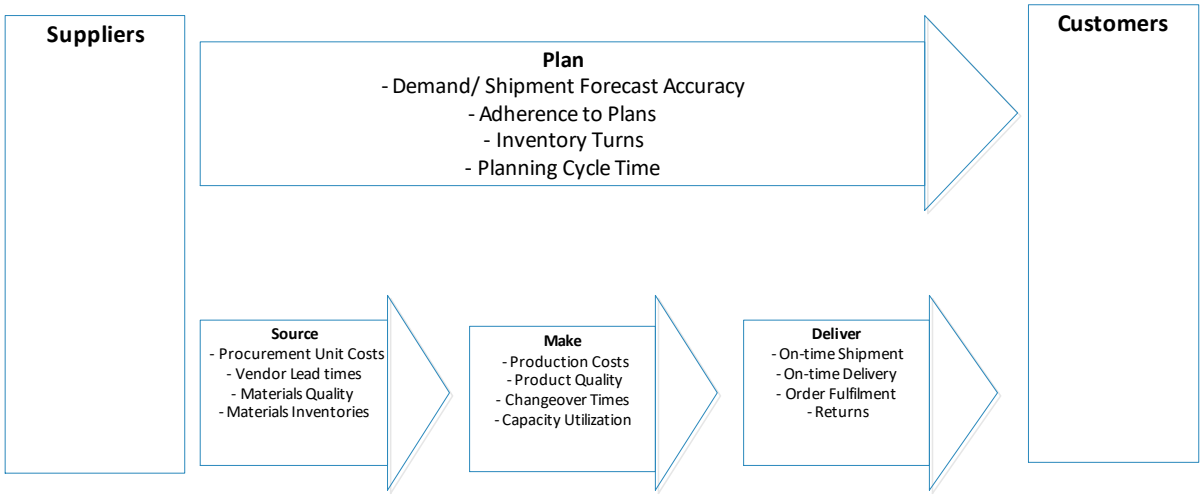

Figure 2.21 Illustrative performance measures based on SCOR Model (Lapid, 2015)

The SCOR model benefits users by using standard descriptions of management processes, standard metrics to measure process performance, management practices that set out benchmarks and also standard alignment to information systems features and functionality

that enables best practices (Theeranuphattana and Tang, 2007). The SCOR model directly addresses the needs of supply chain management with balanced measures. However, disadvantages include a lack of strategic orientation of the model (Theeranuphattana and Tang, 2007). In supply chain research, the framework have been used for evaluating performance in transport logistics highlighting that the model "represents a systematic approach to measuring performance with inputs from, and outputs to, member firms in the supply chain and considers performance assessment on a supply chain-wide basis… This is an important point because it not only identifies both the effectiveness and efficiency aspects of performance, but also recognizes that there can be internal as well as customer-related reasons for performance measurement" (p. 443, Lai et al., 2002). Further examples of application of the framework in the commodity supply chains research have been limited (Aramyan et al., 2007).

2.5.1.3 *Other Performance Measurement Frameworks*

Logistics Scoreboard approach was developed by Logistics Resource International Inc. (Atlanta, GA) who recommended using an integrated set of performance metrics within the following categories (Lapide, 2015):

- Logistics financial performance measures (Returns on assets)
- Logistics productivity measures (deliveries per time period, container usage)
- Logistics quality measures (errors, defects during shipments)
- Logistics cycle time (in transit time, demurrage)

This approach is clearly focused on the shipment and logistics operations of the supply chains without paying required attention to the other functions of the supply chains such as productivity and procurement.

The Activity Base Costings (ABC) approach was developed to overcome the shortcomings of the accounting measures for operational performance. The activities are broken down into tasks which are treated as costs drivers. Then the resources needed for those tasks are estimated, for example, time, finances. The system focuses on accurate costs assignment of

overhead costs to products and processes. ABC has been used to support product decisions, capital investment decisions, outsourcing decisions, environmental management and so on (Tsai, 2015). The ABC approach can be used on its own by will be best applied in conjunction with other more comprehensive metrics.

2.5.2 Performance Measurement Framework for Commodity SC

Some examples of the measures commodity supply chains use to monitor their performance have been presented by Bryceson and Slaughter (2010). The agricultural company that they used in research monitored factors that relate to the movement of goods (cattle in their case) from one property to another in their internal supply chain. Then they used transfer prices received at each stage of the internal supply chain to replicate what would happen with their revenues and expenses on the open market. So the performance is presented in the report that provides valuation of cattle based on market prices, inventory levels less cartage gives them 'transfer margin' which is treated as revenue. The research found that information presented in regular reports doesn't combine operational measures with corporate financial measures in a meaningful way for operational managers. The lack of indicators for actual sales costs versus transfer pricing and any other costs made reports ineffective (Bryceson and Slaughter, 2010).

As for metrics used by commodity trading companies, they are working under standard corporate government guidelines like financial institutions and banks and required to deliver best return on investment as well as strong risk management controls whilst operating in a unique open market environment to deliver these requirements. This means complex and comprehensive performance metrics are required. Performance metrics should also be flexible to allow for dynamic budgeting, seasonal variations and company capabilities (Merener et al., 2015). Planning and forecasting is difficult because of widely dispersed parts of the supply chain – production, logistics and warehousing are spread around different countries.

2.5.3 Operations Management Theories

There is no single theoretical basis for developing supply chains and improving performance, so a number of organisational, sociology and economic theories are used for understanding different parts of the supply chains (Walker, 2015). The theories include Resource-Based View, Resource Dependence theory, Agency Theory and Relational View, and Transaction Costs. Resource-Based View and Transaction Costs theories will be reviewed at this stage.

Resource Based View suggests that organisations should focus on a firm's strength through the resources it owns rather than environmental challenges and opportunities. The companies here should be considered as a range of specific competencies rather than discrete businesses (Walker, 2015). The firm's tangible and intangible resources can be transformed into short-term or long-term competitive advantages. At the start of theory development, the Resource Based View was primarily concerned with the importance of resources and their application for firms. As the theory progressed, RBV of supply chains now explains the ability of players to deliver sustainable competitive advantage when their resources are managed in a way they cannot be imitated by competitors. RBV was criticised for having a self-explanatory nature (Walker, 2015).

Resource Dependence Theory focuses on dyads and network relationships. The relational view is interested in relationships between organisations, which could be a source of a competitive advantage for the organisation. The investment in 'relations' is considered by companies in case known evidence that the performance can be improved. This means that companies are integrating, going through mergers and acquisitions to minimise their resource dependence (Bode et al, 2011).

Other theories reviewed in detail are Transactions Cost Theory which focuses on companies required to make decision to make-or-buy. The DSS applied in commodity supply chains are required to store cost curves data and help companies make those decisions. Agency theory could be also applicable in this research because traders can be regarded as agents between buyers and sellers of commodities. Moreover this theory is often applied if the information asymmetry is observed which is often the case in commodity supply chains.

Table 2.6 Theoretical framework applied to third-party logistics (adapted from Halldorsson, 2007)

CHARACTERISTICS	PRINCIPLE AGENT THEORY	TRANSACTION COST ANALYSIS	RBV
Behavioral assumptions	Asymmetric information between shipper and TPL provider Goal conflicts	Calculative trust Safeguards, specific investments or long-term contracts	Personal trust Joint learning Transfer of knowledge
Problem orientation	Performance measurement ABC costing, open-book, incentives	Which activities should be outsourced to TPL provider?	Development of competencies internally and between shipper and TPL provider
Time dimension	Static	Static	Dynamic
Unit of analysis	Formal TPL contract	TPL services Transaction costs Logistics performance	Resources and capabilities shared by shipper and TPL provider
Nature of relationships	Adversarial relations Contract influences both the number and nature of outsourced activities	Arm's-length relations Regular tenders to test the TPL market Focus on cost-efficiency Short-term contracts	Complementary resources Creating new competencies through TPL relations
Primary domain of interest	Alignment of behavioral and outcome-based contracts	Investment in specific assets (warehouses, IT, personnel) Minimizing transaction costs	Development of new competencies (e.g. batch monitored shipments, merge in transit, track-and-trace)

2.5.4 Relational View Theory

Dyer (1998) examined interfirm relations within the cooperative networks to find out different rent sources, as well as identifies mechanisms that sustain relational rents emerging from network interoperations. The relational rent is defined as "a supernormal profit jointly generated in an exchange relationship that cannot be generated by either firm in isolation and can only be created through the joint idiosyncratic contributions of the specific alliance partners" (p. 662, Dyer, 1998). This is made possible by sharing resources, knowledge, assets or governance strategies between participating partners.

The interfirm relational assets are divided into 3 categories by their specificity: site, physical asset and human asset. As research has shown, the optimal combination of these three assets improves performance and cooperation. For example, deploying manufacturing close to the resource mining and processing facilities demonstrates site-specific investment and greatly benefits the company. Another strategy to generate rents is to deploy efficient knowledge-

sharing routines, which are defined as a set of “interfirm interactions that permits transfer, recombination or creation of specialized knowledge” (p. 668, Dyer, 1998). Alliance partnerships are greatly strengthened by information sharing and improved specialist interactions. Nonetheless, for knowledge-sharing to be a long-lasting solid investment strategy, alliance partners should enforce incentives for transparency and compensation, maintaining positive feedback and avoiding mindless exploitation. When each partner contributes a unique set of knowledge or resources to the alliance, the resulting synergy creates far superior returns than combined returns of each partner working separately. Even when resources are combined to facilitate relational rents, the realisation of these rents will be possible only if partners employ compatible corporate decision making routines and cultures.

Effective governance is another key factor in making high returns on investment from the partnerships. Two governance categories are defined: third-party agreement enforcement and self-enforcement with no intervention from without (Dyer, 1998). It is argued that as a rule, self-enforcing governance is more effective due to lower transaction costs and higher ‘value-creation initiatives’. In addition, it is hard to anticipate possible corruption schemes or cheating when dealing with contractors. Therefore, once deployed successfully, effective governance is shown to be a reliable source of relational rents.

Preserving relational rents is as important as establishing them. There are certain factors that maintain long-term highly beneficial interfirm relations, such as ‘interorganizational asset interconnectedness; partner scarcity (rareness); resource indivisibility (coevolution of capabilities); or a socially complex, and therefore difficult to imitate, institutional environment (e.g., country specific)’ (p.672, Dyer, 1998). Long-term relations in turn generate another valuable asset, which is trust. It is only attributable to long-term type assets since it cannot be bought or sold or established quickly.

This analysis demonstrates that partners with complementary resources, unique knowledge assets, effective governance strategies can create synergies that generate high returns or relational assets that would not be possible to achieve separately. There is a tendency to much more extensive alliances and partnerships due to much finer specialisation orientation of suppliers and manufacturers, which suggests that competition between single firms, ‘while

perhaps, still true, is becoming less universal, as pairs and networks of firms have begun to compete with each other' (p. 675, Dyer, 1998).

Touboulic (2015) one of the crucial factors in sustaining SSCM is influenced by the strength and reliability of company-supplier relationships. Nevertheless, the research on collaborative SSCM has been quite scarce. In particular, little attention has been given to how SSCM applies outside the process of cooperation between firms on managing environmental factors. A qualitative study on sustainable supply chains is conducted using the example of food industry spanning across multiple countries and collaborating with small suppliers in the agricultural sector. SSC relations strongly correlate with relational theory, such that inter-organisational relations improve the efficient utilisation of resources, where an alliance of companies reaches much better results than the sum of the results achieved by each partner independently. Even if the company acquires unique resources, which helps to secure a strong position in the market, the chances are much higher if it collaborates with other partners. The central idea in the relational view is that of so called relational rents, or in other words, benefits gained from inter-organisational relations. Since the relational view focuses on relations between the firms, it has been widely used for analysing relations between supplier and buyer, specifically focusing on collaboration strategies. With the help of this theory view, critical concepts and strategies for successful supply chain relations have been outlined. One of the factors that improve supply chain collaboration, thus increasing performance, includes knowledge resources, such as know-how, exchange of technical information and communication.

The research has shown that focusing on effective and transparent relational strategies rather than on a forceful approach creates a more favourable environment for better intra- and inter-organisational performance. Collaboration as the main strategy benefits both supplier and buyer, increasing overall efficiency and output of the supplier as well as its overall environmental practices. However, there are still not enough studies that focus on correlation of SSCM and relational view theory. For collaboration strategies to properly translate into increased supply chain performance, a set of relations with other partners, utilising available resources, have to be established. It has been demonstrated that the relational view provides a necessary framework for outlining various relationship approaches in terms of their positive or negative effect on collaborative strategies for achieving sustainability. Lastly, if potential

SC strategies to achieve sustainable relationships are explored, collaboration faces certain crucial roadblocks. Due to the fluctuating nature of environmental factors, sustainability should also be viewed as a dynamic entity. Therefore, it becomes vital to reveal any possible inconsistencies in supply chain relationship dynamics. Suppliers' strategies to achieve sustainability have been researched with quite a narrow set of theories. Instead, the attention has been focused mostly on a coercive approach to building sustainable relations. For instance, a number of papers point out how companies use the strategy of screening the suppliers and choosing them, which violates their internal and external policies. The realisation of these policies is not supposed to resort to screening and stringent selection. Thus, more research is needed in finding alternative approaches to identify an optimal set of strategies for long-term company-supplier relations. See also sub-section 2.4.5.

2.6 Summary

This chapter provided a comprehensive review of the main bodies of literature that informed this research. First the literature review explored the application of Decision Support Systems in upstream supply chains. The number of empirical studies demonstrated that a wide variety of DSS are used in supply chains. The DSS architectures and designs continue to evolve, growing in complexity and sophistication. Then, the value and impact of DSS on performance are reviewed and analysed. It was found that there is a lack of a clear understanding of DSS on performance due to the often qualitative nature of the benefits of such applications (Phillips-Wren et al., 2011). However, numerous studies demonstrate a positive impact and association between information technology and company and supply chain performance. Improved decision making, knowledge management, collaboration and coordination have been highlighted as the main benefits of the use of information technology and DSS in supply chains.

The sub-chapter 2.2 discussed the context of this research – upstream commodity supply chains. The classification of commodities, stakeholders, challenges and processes were reviewed. Further investigation of the SC challenges in sub-chapter 2.3 recognised key distinctions that can be made between four major performance influencing factors – governance, access to trade finance, risk management and high volatility as well as taking account of operational challenges. It has been suggested that studies linking supply chain governance to supply chain performance have been quite scarce (Dolci and Macada, 2014) and a need has been recognised for in-depth research of the market risks across borders (Bonanomi et al., 2016). The sub-chapter 2.4 contextualised and justified the role of intermediaries in supply chains. It was presented that the concepts of upstream supply chain intermediation have not received required attention in the operations management literature (Adebanjo, 2009).

The final focus of this chapter concerned the aspects of performance measurement in commodity supply chains and the relational theory lens used in this research. The relational view suggess that even when resources are combined to facilitate relational rents, the realisation of these rents will be possible only if partners employ compatible corporate

decision making routines and cultures (Fung et al., 2007). This theory was chosen to shed light on the underlying causes of the complexity of the upstream supply chains.

The Research Conceptual model have been developed based on the findings of the chapter. It considers the intermediary performance and supply chains performance been affected by the challenges coming from the complex operating environment of the upstream supply chains. The improvement of the performance can be achieved by introduction of DSS.

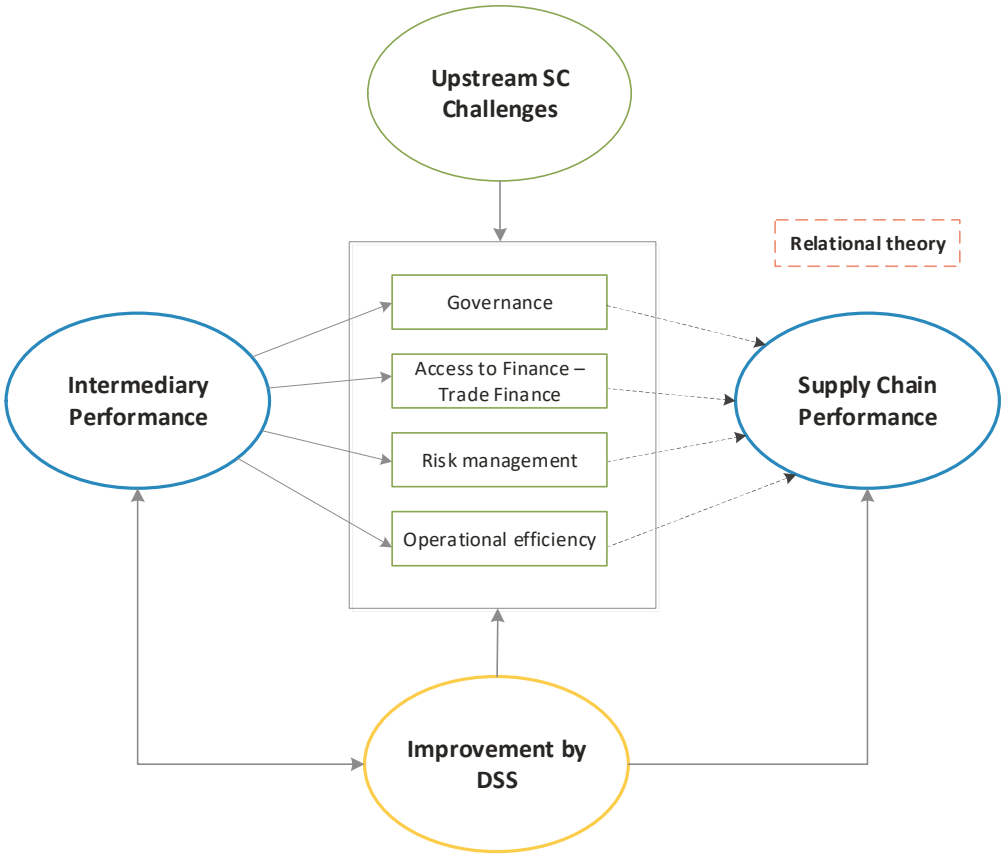

Figure 2.22 Research Conceptual model

The following chapter will present and analyse the methodology adapted in order to best capture the research subject.

3 Chapter 3 Research Methodology

The purpose of this chapter is to outline the research methodology that was employed during the research process in order to achieve the study's objectives. The methodology sets out the criteria and approach that was applied to answer the research questions. Moreover, the rationale and details of the case study method, study design and procedures, as well as data collection and analysis, reliability and validity of results are presented.

3.1 Introduction

The research design should take into account the nature of phenomenon under investigation and overarching theory adopted. The chapter is structured as follows: the research philosophy and background are described, followed by the research method and design of exploratory multiple case studies with use of longitudinal case study design for one of the cases outlined, then data collection methods by observations, interviews and documentation reviews presented, and the data analysis approach explained. The chapter also includes considerations on research validity and reliability as well as ethical considerations.

3.2 Research Philosophy

Research philosophy is an understanding or belief about the way that the data about a phenomenon should be collected, analysed and utilised so that knowledge can subsequently be created (Saunders, 2012). Research philosophy has an impact on the research design in terms of method selection, analysis and interpretations of data.

There are a number of underlying philosophical paradigms that are believed to drive researchers understanding of the world and ways of conducting research and data analysis. Different research paradigms are trying to answer the question of the relationship between the science and a man (Wright, 1971). It's been suggested that social sciences are best represented by the phenomenological - constructivist stand, which puts the researcher into a central position and allows more flexibility and resourcefulness in research approaches, whilst natural sciences, which majorly adopt a positivist stance, do not recognise the role of the inquirer in the outcomes of his research and claims that in order to prove a theory it has to be measured leaving no space for creative, at times, spontaneous and independent researcher interpretations (Guba and Lincoln, 1994).

Historically, management studies were not trying to provide sophisticated descriptions and compared organizations to machines; and organizational studies were looking for generic rules and regulations of organizational behaviour. Only years after the focus shifted towards the understanding of meaning, context and reflexivity in business studies (Tsoukas and

Cummings, 1997). Researchers started looking deeper into a subjective element in an organisational context – human nature, behaviour, relationships, etc. (Tsoukas and Cummings, 1997). As for current developments in management research, Ramsey (2013) suggests that the majority of research is mainly focused on emphasising the necessity for new practice rather than the knowledge needed for the application of this practice (Ramsey, 2013).

This study is influenced by scholars such as Narasimhan (2014) who discusses theory development in the operations management research field. The author suggests the growing importance of qualitative research in operations management by emphasising the increasing challenges that supply chain participants face in a rapidly changing global economy and added contextual complexity of the international operations. The author describes the historical development of operations management research in order to support his claims. Formerly, academic investigation focused on the production optimisation and general plant operations; the next phase of research looks at the manufacturing strategy where a multidisciplinary approach first started to appear, presenting connections between procurement, logistics and competitive advantage and competition. The current phase of operations management research is characterised by the need for wider research concerning supply chain participants, manufacturing strategy and supplier involvement in the product development process. Qualitative research methods dominate here due to the need for a rich description of the discussed phenomenon (Narasimhan, 2014).

Narasimhan (2014) raises concern that "theory defines a scientific discipline, yet the supply chain management discipline has largely failed to develop its own theoretical bases" (p.215, Narasimhan, 2014). The need for emerging new theories in operations management is high. Similar ideas were proposed by Suddaby (2011) when he talks about organisation management research (Suddaby et al., 2011). These concerns only support the need for robust qualitative studies through case studies, which will be able to provide practical idea insights into observed phenomena, which will then be developed into theories.

There is a misconception in management theories made by an assumption that management and business activities are well thought through and decisions are made through careful

conscious analysis (Zundel and Kokkalis, 2010). This assumption is widely criticised due to the fact that subconscious and irrational decision-making is a part of human behaviour.

The complexity of upstream supply chain, governance structures and uncertainty surrounding global operations contribute to the need for a deeper investigation of the phenomena (Carter, 2015). A qualitative approach was employed in this research in order to describe the inside of the intermediary trading processes, the DSS employed that influence the company performance and the performance metrics used. Moreover, application of qualitative methodology in this research allowed to observe the phenomenon unfolding in real-life settings (Patton, 2003).

3.2.1 Choosing a Qualitative Research Methodology

Methodology has been described as the 'philosophy of scientific method' and its main goal is to provide appropriate research questions by means of achieving credible results (p. 3, Wright, 1971). Generally speaking, qualitative research is oriented towards the analysis of the context, specificity and finding the nature of the meaning (Irwin et al., 2012). Traditionally, it was believed that only the quantitative research was able to provide new knowledge (Irwin et al, 2012), but on the other hand qualitative research was criticised for weak validity of its findings (Van Maanen, 1979). However, qualitative methodology has great potential in achieving new findings of the researched phenomena mainly because of its approaches and data collection methods.

The qualitative methodology is described by Van Maanen (1979) as a set of 'interpretive techniques', which are aiming to understand and formulate the meaning of particular phenomena in social sciences. Easterby-Smith (2008) are talking about pluralism of qualitative research, which incorporates multiple methods, such as – ethnomethodology, action research, narrative analysis and many others. Despite the large number of methods in the qualitative research canon, Van Maanen (1979) showed concern regarding whether these methods can provide meaningful data, especially when interpretation techniques are making it 'fluid, contingent and open-ended' (p.522, Van Maanen, 1979).

As noted above, interpretation is a significant part of qualitative research, but it is a weakness at the same time. The researcher needs to be able to interpret symbolic, reflexive, contextual and even 'intimate' data from the participants (Van Maanen, 1979). Moreover, the qualitative research data consists of the analysis of social processes, personal experience, behaviour and any other observations. The attempt to analyse and make conclusions from such data poses difficulties to the researcher to make his judgements and interpretations in order to produce new knowledge (Van Maanen, 1979).

3.2.2 Justification of Case Study Method

The research strategy for the study is described by an inductive approach, which is described as bottom-up approach involving transformation from specific cases to general definitions. In this research to gain insights into how the upstream commodities' supply chains operate and how they manage the challenges arising from market volatility, price dependency and regulatory changes. The study will discuss DSS used by the participants of the supply chain and how this affects performance on two levels – the company level and the supply chain level.

Case studies research was described by Eisenhardt (1989) as 'a research strategy that involves using one or more cases to create theoretical constructs, propositions and/or midrange theory from case-based, empirical evidence'. The main characteristic of case study research is that it provides a rich, real-life context in which phenomena take place (Eisenhardt and Graebner, 2007). Yin (2009) further described it as an 'empirical inquiry that investigates a contemporary phenomenon in depth and within its real life context, especially when the boundaries between phenomenon and context are not clearly evident' (p. 18, Yin, 2003). The main objective of this method is to record the actual meaning and interpretations of the participants describing the phenomenon of study (Johnson et al., 2006, Tsang, 2014).

Case study research has a number of attractive features such as the ability to present a rich picture of the phenomena, but it is also characterised by challenges of producing data with little chances for generalisability into a theory (Eisenhardt, 1989). Other authors support this idea. When talking about case studies in operations management, Narasimhan (2014)

identifies the importance of case studies in revealing and establishing the presence of a phenomenon, but might not be sufficient for full theory development, but primarily used for 'drawing the attention of researchers to interesting theoretical issues' (p. 215, Narasimhan, 2014). A case study proliferates the knowledge about the phenomena and is extremely important in the analysis of organisation studies, person experience and relationships (Stake, 1978). The main strength of the case study is the ability to deal with a variety of evidence – documents, interviews and observations (Stake, 1978).

Studying the phenomenon in its context is central for case study research (Yin, 2003) and means that research focuses on actual tasks and processes taking place in organisations (McLeod et al., 2011). This will provide a rich understanding of social interactions and organisational practices in the specific context, which may bring insights to other organisations and commodity supply chains. In addition, case study research was chosen because it allows some flexibility in research design which can be adjusted during the study in order to adapt to the changing environment in which the phenomenon takes place (McLeod et al., 2011). In this research, case studies allow the possibility of achieving an in-depth understanding of the adoption and use of DSS that involve complex interrelationships between people, processes and procedures, politics, culture, and inter-company communications (McLeod et al., 2011). Case study research involves close interactions with research participants. It is suggested that getting access to actors directly and prompting their interpretations through conversations or interviews is the best approach to understand social processes (McLeod et al., 2011).

The research concerning the effect of DSS on business performance mainly based on quantitative methods (Luo et al., 2002; Chae et al., 2014; Kardas et al., 2014; Kovach et al., 2015; Tenhiälä, A. and Helkiö, 2015) which do not give insightful details and knowledge. A case study can help identify the important contributing factors for relationship between DSS and company and supply chain performance especially in the context of commodity supply chains where factors like trust and relationship play crucial role.

3.2.3 Characteristics of the Case Study Method

There are three case study approaches identified (Yin, 2003):

- Descriptive case studies are used in cases where rare events or phenomena are presented
- Exploratory case studies are for exploring the phenomenon that is not well understood or lacking theoretical grounding and will produce insights for future research (McLeod et al., 2011). Exploratory studies in operations and supply management research is highly complex and requires a better understanding of human factors as well as requiring new theory building
- Explanatory case studies focus on providing a theoretical explanation for phenomena and questions asked in the research addressing “how” and “why”.

This research is exploratory in nature, with the methodology based on a multiple case study approach, of which two of the case studies are longitudinal in nature. The research followed the case study framework proposed by Yin (2003) and presented in Fig. 3.1.

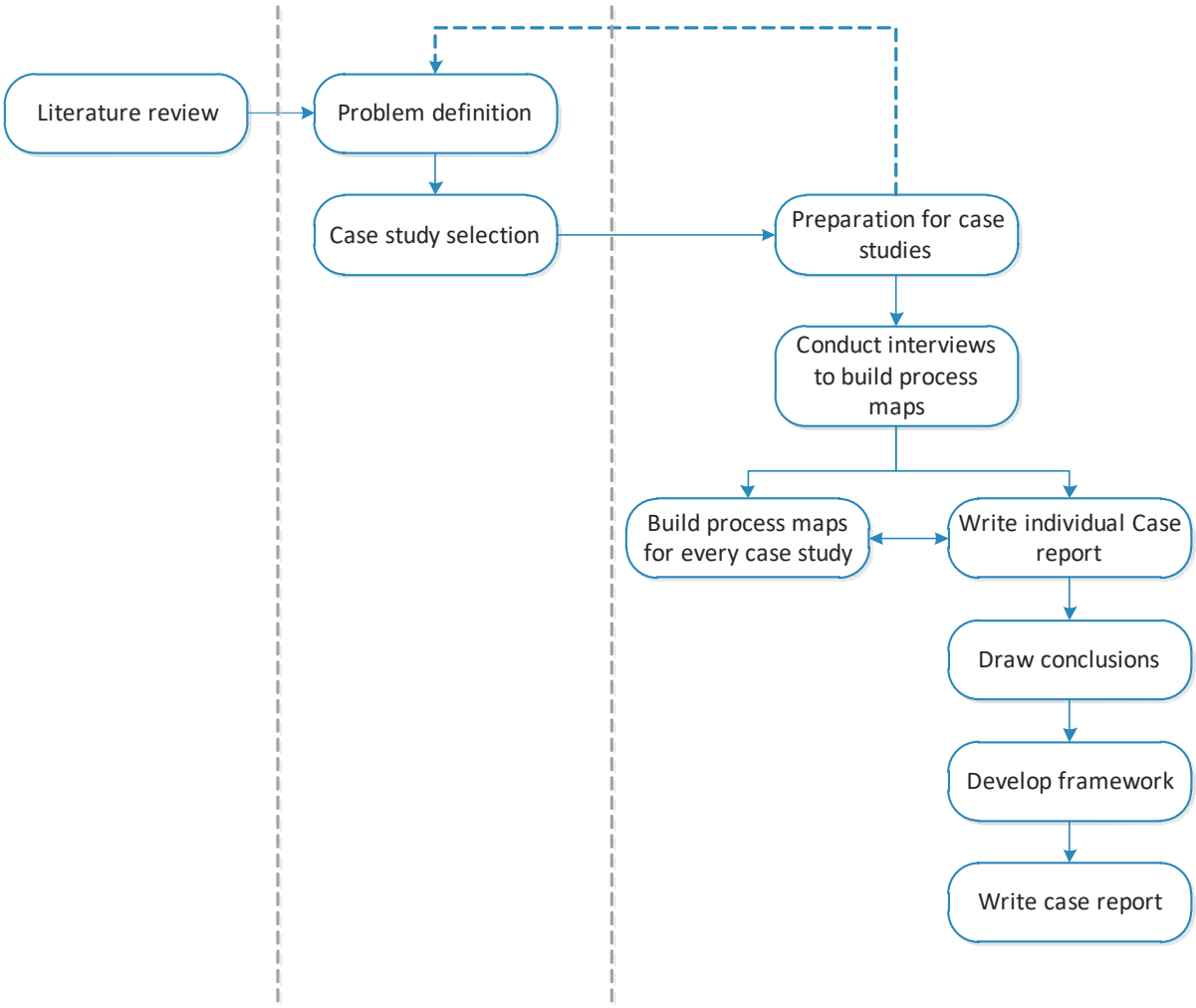

Figure 3.1 Case Study Design (adopted from Yin, 2003)

The research design aims to ensure that the research questions are addressed in a structured way whilst answers are analysed in an appropriate manner. There are a number of types of research designs including longitudinal, single and multiple case study designs among others that have been considered and used in this research.

3.2.3.1 *Single Case Study Research Design*

Case study research design can involve single or multiple case studies. The main reason for using a single case study design, as highlighted by Yin (2003), is for presenting a critical case to test a theory or representative case to report general experiences (Yin, 2003). Other authors add that single case studies may also be used to conduct holistic and in-depth

analyses of one situation (Langley, 2011). This is commonly used by interpretive researchers aiming to provide rich descriptions or explore a previously under-researched subject. The use of a single case study is claimed to be error prone due to the inability to conduct a comparative analysis (Patton, 2003). A single case study methodology is best suited to research that is associated with testing well-formulated theory or used for studies that are aiming to present phenomenon for scientific investigation (Patton, 2003). These issues contributed to the decision to conduct multiple case study research.

3.2.3.2 *Multiple Case Studies Research Design*

Multiple case studies are used as a method when research is searching for common patterns among various cases (Burawoy, 2009; Tsang, 2014). The evidence obtained from multiple case design is often more compelling (Yin, 2009) and provides a stronger basis for theoretical generalisation (Tsang, 2014). Tsang (2014) also presented what types of contributions can be achieved through application of the case study research (Fig. 3.2). Empirical generalisation commonly achieved by case studies is aiming to find whether there is any regularity among the participants, whilst theoretical generalisation provides theoretical explanation of the regularity (Tsang, 2014). Both approaches contribute to theory building directly or through direction for future research.

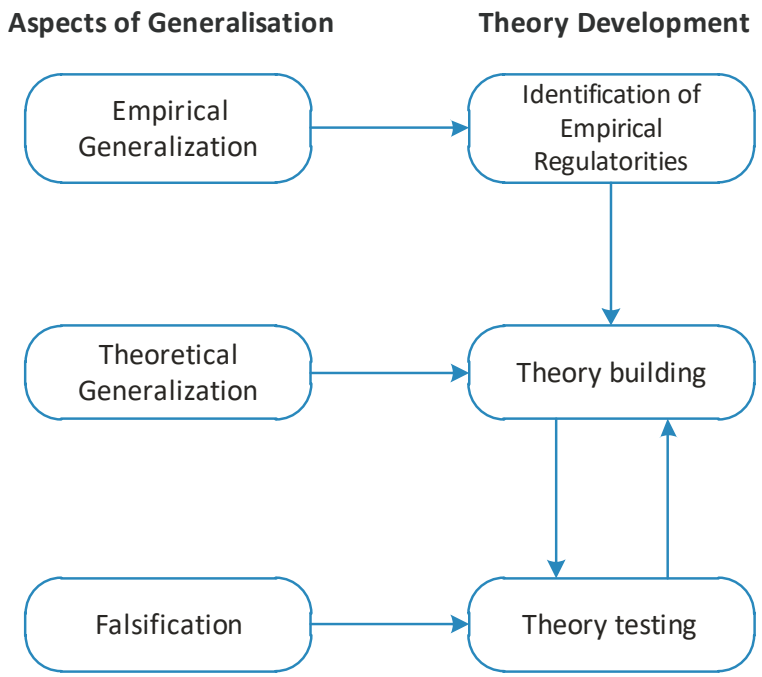

Figure 3.2 Contributions of case studies to theory development (Tsang, 2014)

Multiple case study research is usually used to replicate the same scenario in different settings in order to compare or contrast results (Yin, 2003). Multiple case study research is especially appropriate for complex research that involves numerous actors and aims for description, theory building or theory testing (Yin, 2003). A multiple case study approach was adopted for this research to allow outcomes to be better validated.

3.2.3.3 *Longitudinal Case Study Research Design*

Longitudinal case study design is recognised to allow for the collection of robust data which provides a stronger foundation for theoretic generalisation (Tsang, 2014). In such case studies, data is collected over an extended period of time to explore how conditions change throughout time (Yin, 2003). The aspect of change is the main focus in longitudinal research – how change is created, causes and consequences of change (Neale, 2011). A longitudinal case study enables a phenomenon to be observed as it happens, describing events as they occur and analysing participants' actions and interpretations over time (Mcleod et al., 2011).

Another advantage of longitudinal research is the possibility to observe and capture the details and 'twists and turns on the ground' which allows the ability to create a very specific

rich picture of the case. This data allows for tracing the dynamics of a changing and volatile environment of commodity trading supply chains and interactions with counterparties and company engagement with DSS. Such complex and frequently changing conditions can be difficult to capture by other research methods (McLeod et al., 2011). Longitudinal research is able to produce 'distinctive forms of knowledge in a circumstance where we are facing rapid social change' (Neale, 2011) and "can support the construction of holistic explanations of the outcomes of complex social processes" (p.432, McLeod et al., 2011). It has been decided to incorporate the longitudinal case study approach for some of the cases as they were going through the process of implementation of the DSS and a 'before' and 'after' analysis could be conducted thus allowing to study and understand the full effect on performance.

3.2.3.4 *Process Mapping*

Process mapping is described as "a method of identifying the formal and informal structures and processes within an agency or organisation involved in the delivery of a particular function" (Lewis-Beck et al., 2004). Process mapping is commonly used to achieve an understanding of mechanisms underlying the phenomena to be evaluated. This method can help explain the reasons for success or failure of change and inform the research process in terms of the types of data that should be collected through identification of crucial points that require measurements (Lewis-Beck et al., 2004). Process mapping was used as a prerequisite to semi-structured interviews in order to achieve a thorough understanding of the processes and functions of the commodity trading companies and identify the most crucial steps that affect company performance. Moreover, follow-up process maps were constructed for two of the longitudinal case studies in order to observe the changes introduced by the adoption of DSS. Process mapping in this research allowed to provide a full picture of the operational context of different companies and helped explain differences in companies' performances and research outcomes.

Combination of different approaches and methods in this research provides a more comprehensive view of performance changes in operations of companies in upstream supply chain.

3.2.3.5 *Case Study Generalisation*

Generalisation from case studies has been recognised as difficult especially when there are only a few case studies. In order to provide results that will be generalisable across the field of study it is important that to ensure external validity during the execution of the research design (Gioia et al., 2013). Despite difficulties in generalisability in qualitative research, Stake (1978) suggests that the reader will be able to better understand qualitative research results by relating them to personal experience which is a 'natural basis for generalization' (p. 5, Stake, 1978). As far as this research is concerned, the cross-case study method was applied in analysing three case studies so that generalisation can be made for wider context of commodity trading companies.

3.2.4 Reliability, Validity, and Trustworthiness of Research

Despite the limitations and difficulties of the qualitative methodology, authors are looking for ways of ensuring quality in qualitative research. Easterby-Smith et al. (2008) claim that there are a number of quality criteria for the qualitative research, such as the description of a chosen method and methodological tradition, clear outline of aims and objectives of research, and demonstration of theoretical novelty. Undoubtedly, the quality of gathered data is one of the major factors in achieving overall quality of research (Van Maanen, 1997). First of all, the data was collected from different sources in order to increase validity and reliability of the research design. Furthermore, the evidence was triangulated with data and information collected from other sources such as reports and direct observations.

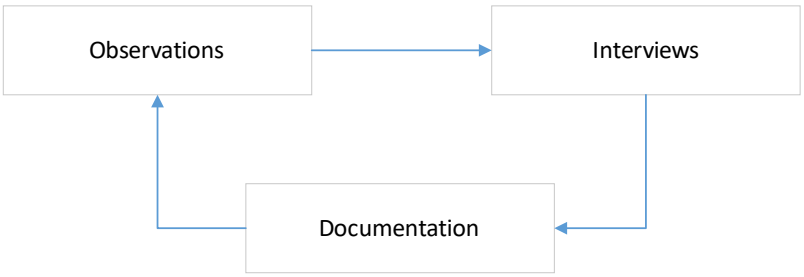

Figure 3.3 Triangulation by method (Easterby-Smith et al., 2008)

Different types of validity and measures taken are explained in Table 3.1.

Table 3.1 Types of validity in case research and how research design address them (adopted from Vlanchos, 2015)

TYPE OF VALIDITY	DESCRIPTION	MEASURES
CONSTRUCT VALIDITY	Establishes correct operational measures for concept studies	Construct validity was ensured with multiple sources of data. Respondents presented with the performance measures used in this research and they opportunity to comment on them
CONTENT VALIDITY	Establishes that the measure includes all aspects of the concept or construct to be measured	Debriefing with participants in regards to language used was undertaken. In addition to that prior to the interviews common terms and substitutions used in the industry were considered. All the concepts like Risk management explained. Participants were asked to explain concepts based on their understanding to reach common definitions.
INTERNAL VALIDITY	Establishes a casual relationship, whereby certain conditions are shown to lead to other conditions as distinguished from serious relationships. This type of validity is applicable to explanatory or casual type of studies	This research was exploratory in nature and did not require to make causal statements.
INTERPRETIVE VALIDITY	Establishes the operational measures were interpreted to conceptual level	Interpretative validity was accomplished by iterating discussions to validate that ideas, propositions and plans were understood in the same way across different time periods
CONTEXTUAL VALIDITY	Establishes that measures and concepts were captured and interpreted taking into account the context from which they emerged	Contextual validity was supported by field notes taken during on site observations and interviews to make note of context for DSS implementation and commodity trading environment.
EXTERNAL VALIDITY	Establishes the domain to which the study's findings can be generalised	External validity was established by use of multiple case studies in this research.

Padgett (1998) proposes six ways to enhance the rigor of the research such as:

- Prolonged engagement
- Triangulation
- Peer debriefing and support
- Member checking
- Negative case analysis
- Auditing

Three of the recommendations have been used in this study: prolonged engagement through longitudinal case study, triangulation from different sources of data and peer debriefing and support by the supervisory team were adopted.

As for trustworthiness, the studies that adopt interpretive paradigm rely on trustworthiness whilst research in positivistic paradigm focuses on criteria of internal and external validity, reliability and objectivity (Lincoln and Guba, 1985; Padgett, 1998). It is suggested that four factors should be considered in establishing trustworthiness in qualitative research: credibility, transferability, dependability, and confirmability.

Onwuegbuzie et al. (2010) outlined the biases which exist in qualitative and recommended ways of ensuring trustworthiness of qualitative research. They are claiming that the first bias is the impact of the researcher on the participants and research outcomes and the second bias is the impact of participants and researched information on the researcher. Furthermore, they advise that the critical reflection about these biases will help to avoid the negative influence of these issues on research outcomes.

In the meantime, trustworthiness of data analysis can be supported by debriefing interviews with the researcher on the topics of his understanding of participants and means of nonverbal communication, how the researcher does his interpretations from the data, impact of the research on participants and himself, and any ethical and political issues. Moreover, these debriefing interviews aim for fairness in presentation of the contradictory research results and information gathered from the participants. In order to provide qualitative data analysis which will incorporate all the findings, observations and raw data, Irwin et al (2012) suggested conducting secondary data analysis. It is very helpful as the specificity of qualitative data is in its contextual nature and also because of the difficulty of interpretation of diverse participants. They stress the need for a second review of gathered data by means of

brainstorming sessions or group meetings in order to be able to find any missed out, but important issues (Irwin et al, 2012).

3.2.4.1 *Data Collection Ethics and Confidentiality*

Participation of people is critical for the qualitative research and their motivation and collaboration in conducting the research is extremely important (Pollock, 2012). This is one of the reasons that researchers must carefully treat the ethical procedures. For instance, the research projects involving human subjects require ethical approval by the specialised committees, consent forms are also signed between participants and researcher before the interviews, etc. in order to provide proof and evidence of the compliance of the research process with the academic standards (McCormack et al., 2012). However, there are deeper ethical issues in the qualitative research, specifically in terms of the built relationships with participants and revealing of the information about them. Some of the underlying principles of the research ethics are academic truthfulness, research morals and respect to people (McCormack et al., 2012). The researchers try to remain true to these principles; however there are some ethical issues, which may create serious problems to the research: lack of transparency of the results, revealing or missing out information gathered from personal contacts, colleagues and friends or putting people into danger by revealing their evidence (Taylor, 2011). Pollock (2012) also provides a critique that the consent forms are not always read and understood by the participants and in that case cannot provide reliable proof.

On the other hand, researchers are concerned that complicated, time consuming and restrictive ethics approval procedures, which are aiming to protect participants, can supress research objectives and method (Pollock, 2012). At the same time, these procedures help improve the quality of qualitative research and help the researcher to understand the needs and requirements when working with people and protecting their integrity. The research ethics approval has been obtained from the University of Liverpool Ethics Committee (see Appendix 20).

3.3 Research Design

Research design is described as 'the overall configuration of a piece of research: what kind of evidence is gathered, from where and how such evidence if interpreted in order provide good answer to the research question(s)' (Easterby- Smith, 1991 in Vlanchos, 2015). In this research, a three-step approach was adopted – literature review and planning, longitudinal observations and process mapping, semi-structured interviews and triangulation analysis (see Fig. 3.4). The research approach chosen characterised as multiple case studies including two longitudinal exploratory case studies and one retrospective case study to address research purpose to better understand how DSS in upstream supply chains can provide improved business and supply chain performance through enhanced decision-making based on appropriate data access, and enhanced operational and inter-organisational activity visibility. Moreover, independent respondents representing field experts are recruited to provide additional information and context for upstream supply chains and intermediation for raw commodities. The companies' primary traded commodities include rubber, cotton and coffee. The data was collected during onsite visits for two longitudinal case studies and by means of electronic communications and web-conferencing software.

The research design of this study involves two type of case studies. Case studies type A are longitudinal case studies that were observed throughout the period of implementation of the information management architecture. This allowed for mapping of the operations and processes "before" and "after" the information systems were adopted. Case study type B is a retrospective case study with the company that have been using the information systems for a number of years.

As Fig. 3.4 illustrates, initially, extensive literature review of three main bodies of work in this research including upstream supply chains, intermediary trading in supply chains, DSS application in supply chains and company and supply chain performance. This phase informed and allowed to better structure the first and second qualitative data collection phases as well as help answer to answer research question one. The main performance criteria for intermediary trading companies and drivers for adoption of DSS were also identified including supply chain governance, access to finance, risk management and operational efficiencies as

main drivers of the upstream commodity supply chains. The next step of research included on-site observations and process mapping of company operations.

The active phase of the research started with on-site observations with first and then second longitudinal case study companies accompanied with semi-structured-to-informal interviews. Company business processes, internal standards, reporting and communication were examined with respondents and written down by the interviewer. This stage represented the first series of interviews that took place at the start of the implementation process and consisted of gathering background data on the company and their business processes, their decision to adopt DSS and expectations for the impact of DSS on company's operations. In addition, semi-structured interviews were conducted with industry experts and consultants to gather rich information on the study context and understand their perception of the performance changes due to DSS in the upstream supply chains. The industry experts included marine insurance company, financial consultants, and experienced industry professionals.

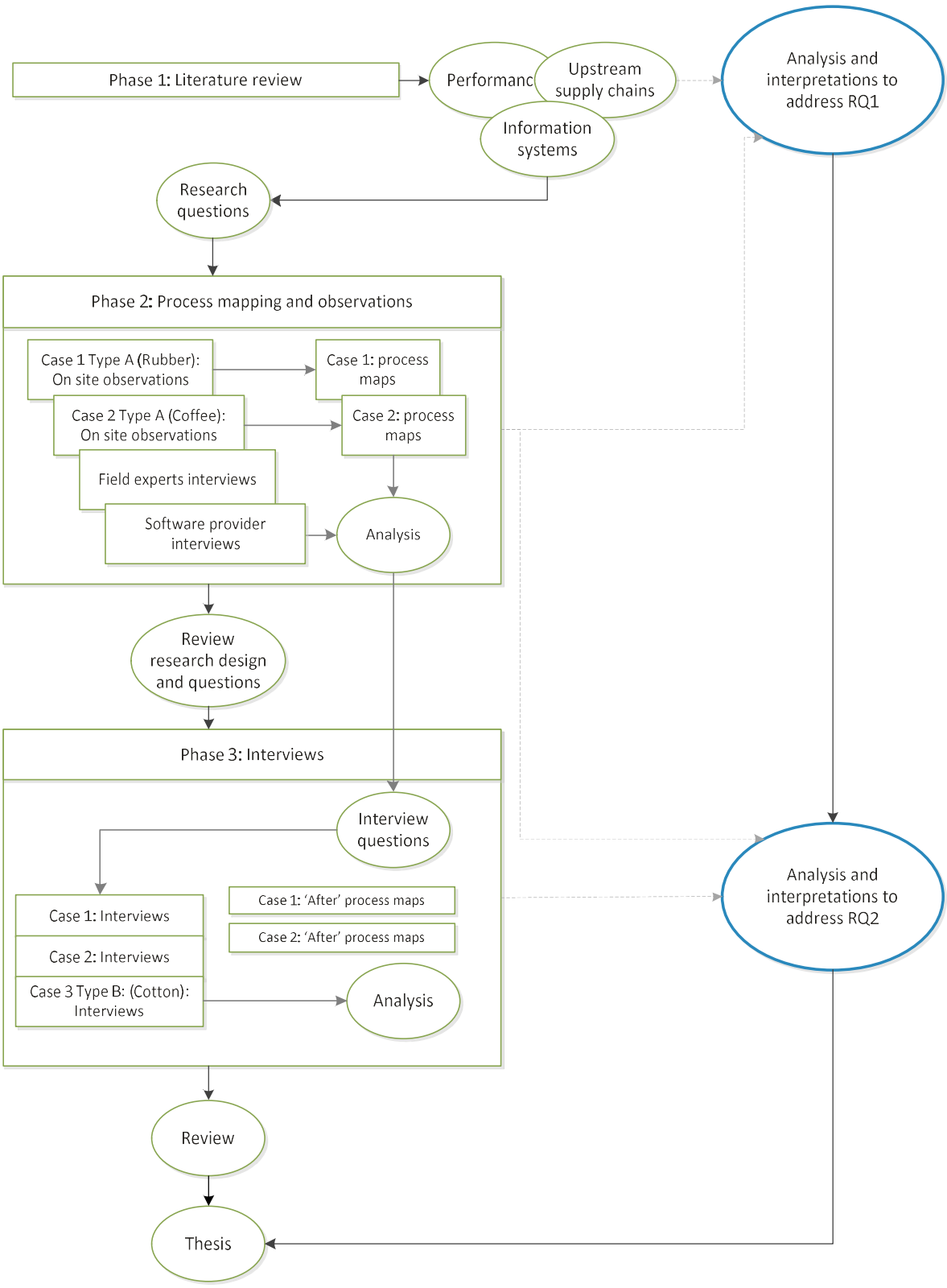

Figure 3.4 Research design

The third phase of research involved a series of secondary interviews with case study 1 and 2 and accompanied with continuous on site observations of implementation processes to review the changes in processes after the implementation period. The case study 3 reviewed company's processes and performance with the DSS retrospectively. The refined conceptual model for supply chain challenges and company performance was used as basis for semi-structured interviews to document their experience and any definable outcomes. Through number of reviews performance changes revealed and process mapping complete.

The case study 2 was conducted between January 2016 and September 2016. It was intended to follow the project through initiation and vendor selection, project planning and DSS implementation, and if possible the post implementation period. The field work was undertaken on-site at the commodity trading company and additional time spent with the systems producing company. On average, the researcher spent about a week every month on site with the trading company and two to three days a week onsite with the systems providing company. The observations were undertaken during periods of main interest and that represented some core project activities. Project tasks like project initiation workshops and progress meetings, 'proof of concept' and 'scenario testing' workshops, KPI definition and specification workshops and training sessions were also undertaken. Additional follow up visits were completed until project closure represented by when the trading company used the system in question. Regular email and Skype conversations were scheduled with the main project participants to keep informed on progress when onsite visits were not feasible and during less intense periods of the project.

3.3.1 Case Study Participants

The companies participating in the research are representative of upstream supply chains. The three case studies are sourcing intermediaries. Other participants include supply chain actors that had trading relationships with intermediaries or had any other ways of engagements in commodity trade. The role of intermediaries in upstream supply chains is particularly important and been described in detail in Chapter Two. However, the other supply chain participants are important to include in the research in order to truly understand

the trends of development, governance, visibility and traceability and performance improvements across the entire supply chain. These additional participants of the research have been represented by the supply chain experts who have profound experience and understanding of the field. The working experience of the respondents in the commodity trading supply chains is more than 10 years. The knowledge and expertise of the interviewees in the field of commodity trading and working with interviewees contribute to the validity of results. Additionally, another research participant was the producer of one the DSS used by intermediary trading companies.

List of case studies and research participants included in this study presented in the Table 3.2.

Table 3.2Case Study participants

CASE	DESCRIPTION/COMMODITY	COMMENT
CS 1	A subsidiary of multi-national commodity trader – rubber and latex	Participants included finance director, project manager, senior traders and logistics managers for liquid and solid goods
CS 2	Coffee trading company - Specialty Coffee	Value adding to the supply chain with cupping/sampling of specialty coffees. Participants include CEO, senior trader, project manager, logistics manager and finance manager
CS 3	A subsidiary of multi-national commodity trader - Cotton	The participant is managing director and former senior manager within the same organisation
PARTICIPANT 1 (P1)	Former cotton merchant in large commodity trading company, but assets in cotton farming in Africa	Extensive experience in cotton trading and development of end-to-end sustainable supply chain
PARTICIPANT 2 (P2)	Marine Insurance Company (soft/agricultural commodities)	Experience working with intermediary organisations as well as directly with suppliers and buyers. Position of service provider for intermediary organisations
PARTICIPANT 3 (P3)	Supply chain consultant/advisory	Previously worked as a full-time farmer in the UK during which time he was a founder demonstration farm for LEAF and Nuffield Scholar. Conducted advisory work for a range of clients from multinational companies, multilateral agencies such as the UN and World Bank related entities and family offices

PARTICIPANT 4 (P4)	Commodity trade consultant (oil, gas and agricultural commodities)	10+ years' experience working with commodity trading companies and help in pricing and valuations algorisms for commodities
PARTICIPANT 5 (P5)	Information Technology producing company	Access to project meetings, negotiations for the systems customisations and project documentation

The participants were recruited by means of purposeful snowball sampling. This study is focusing on the quality rather that quantity of cases in order to collect broad information on the topic (Padgett, 1998). Participants were approached through information technology provider and agreed to participate in the research based on voluntary and informed consent. The snowballing approach allows to recruit participants with specific relationships within the supply chain, i.e. between intermediary and buyers, suppliers, and service providers. Furthermore, the structure and participants of the upstream supply chains are not always clear, specifically when it comes to the position of intermediaries - they may not be formerly identified in the division of labour among actors in the supply chains (Vedel, 2013). In addition to that, information about smaller sized intermediaries is harder to obtain together with their links to other counterparties. For such cases, snowball sampling is an appropriate method (Atkinson and Flint, 2001; Noy, 2008). Some information collected in the research can be considered sensitive for participants and directly relating to their competitive advantage so only some participants were able to refer research to their counterparties. Confidentiality agreements were offered to the participants in the event that they would prefer to remain anonymous in this study and in possible future publications.

As the research method chosen is a multiple case study a selection of research participants described as theoretical sampling (Eisenhardt, 1989) - 'the process of data collection for generating theory whereby the analyst jointly collects, codes, and analyses data and decides what data to collect next and where to find them, in order to develop theory as it emerges' (Lawrence and Tar, 2013) in order to show a clear picture of the process/information flow and relationships within particular type of supply chain – upstream commodities supply chain.

3.3.2 Data Collection Methods

In this research, the three case studies are intermediary commodity trading companies that are different in size and primary traded commodities. The DSS used by the companies vary by systems provider or configuration and system customisations. The primary data was collected from interviews and participant observations during day-to-day operations of the trade process as well as logistics, accounts and executive management. Onwuegbuzie et al. (2010) claimed that nonverbal communication is as important to the research as the evidence gathered – "nonverbal communication also can be important for attaining a deeper shared meaning" (p. 699, Onwuegbuzie et al., 2010). It is important for the research to record not only the expressions and opinions of the participants, but also observations of the environment, human behaviour and analysis of the nature of their topics, whilst the participants' body language could be taken into account as well (Watt, 2007). The signs of nonverbal communication include gestures, facial expressions and other body language attributes (Onwuegbuzie et al., 2010, Pezala et al., 2012). Secondary data also collected from the documentation provided by the participants as well as acquired from public databases.

In the first case study, the interactions with participants were prolonged over a sixteen months period, whilst the second case study was considered over an eight months period. The observation of processes and events as they occur provides insight into practices, processes, operations and internal interactions and allows to reveal the progression and consequences of changes observed. Case study research tends to treat verbal reports of conversations, behaviours and events as being unable to include the necessary details to gain an indepth understanding of processes under study (Woodside, 2010). It is suggsted that interview data alone is not sufficient for developing ethnografic (analytical) interpretations and should be combined with long-term participant observations in a cultural context or common environment (Woodside, 2010).

1.2.1.1 Observations

In this research, observations were one of the key sources of data. The participant observations were undertaken over an extended period of time engaging with the project participants. The daily operations of the commodity trading firm were observed in natural day-to-day settings including the process of negotiating purchase and sales contracts, 'spot sales', hedging, the sampling process and shipping of goods; as well as activities specifically relating to the project of implementation of commodity trading management system such as gap analysis and project meetings. Close involvement with the researched phenomenon in its daily environment allows to collect substantial contextual knowledge to be able to conduct interpretations of the observed. In addition to that, an inside view on people and events helps in understanding the depth of the phenomenon.

The researcher had access to work space in the company developing DSS and was able to attend meetings, workshops and training sessions. The researcher was free to engage in informal conversations and ask questions as well as access project and company documentation that has been attached to any electronic communication and printed form. Informal interviews are part of the process of general interactions during observations, allowing to observe people in natural settings and looking for difference of opinions. Activities that have been observed on-site included project management activities for planning and actual execution of the project, development cycle for new system functionality, customisations and testing as well as delivery of project documentation.

Table 3.3 Summary of types formal meetings observed with Case Study 1, 2 and 3

MEETING TYPE	CASE STUDY	NO OBSERVED	TOTAL TIME APPROX (HRS)
IT DEMONSTRATIONS AND PRESENTATIONS	CS1 and CS2	21	168
PROJECT TEAM MEETINGS (DURING IMPLEMENTATION PERIOD, INCLUDING WEEKLY MEETINGS)	CS1, CS2 and Participant 5	33	14.5
PROJECT KICK OFF MEETINGS AND PROOF OF CONCEPT MEETINGS	CS1 and CS2	4	24

ANY OTHER PROJECT MEETINGS WITH CASE STUDY COMPANY	CS1 and CS2	4	4
TRAINING SESSIONS AND TESTING SESSIONS OF SOFTWARE DEVELOPMENT	CS2	10	40

The author took field notes on a notepad and then transcribed responses. During observations, the researcher had a number of areas of primary concern:

1. Conversations, behaviours, events that occur in the process of observations
2. Understanding from the literature of how the specific tasks (process of agreeing a contract via intermediary) and any differences with real life settings
3. Participant's perceptions of the impact of DSS in the organisation and the changes in the processes that are being examined

3.3.2.1 *Interviews*

The interviews in this research have been undertaken in two stages. Primarily, the participants were interviewed in order to collect information to map out the company business processes 'before' and 'after' the implementation of DSS. The use of process maps allowed for better understanding business operations and changes occurred. The processes that have been transformed after the use of DSS were analysed and further reviewed by a second series of semi-structured interviews. The interviews helped to understand further in-depth complexities of upstream commodity trading and perceived performance changes.

The participants selected for interviews from case study companies had comprehensive knowledge of various company's operations and business processes – trading, logistics and strategy and considered decision-makers in the organisation in order to answer the questions regarding company operations. Moreover, people interviewed should have been involved with the process of selection and implementation of the DSS in order to collect comprehensive evidence.

Semi-structured interviews were used for data collection in this research. It is suggested that such interviews give more latitude for probing at the same time as providing a clear framework across interviews (May, 2001). In designing the interviews the iterative and flexible approach was chosen – findings and issues identified in earlier interviews were used to amend or add to the original set of questions. The interviews with intermediary trading companies included questions such as: "How you reduce supply risk for your customers"; "how other intermediaries that you know of reduced supply risk", "what are your relationships with other participants of the supply chain", "how do you measure your performance" and "what do DSS mean for your business/task". The interview questions were tailored to the functional and knowledge area of the participants such as logistics and accounts. If possible, more than one person was interviewed from every department within the trading company to ensure that there were no gaps in data. The interviews with other supply chain participants (supply chain consultants, marine insurance company) about their interactions with sourcing intermediaries and how they managed to reduce risks for them is considered, alongside how this affected the performance of their own organisation by using examples. In addition to that, a number of informal conversations were held during the observation stage. The interview guide was prepared to provide structure to the interviews even though they were conducted in a conversational manner. Moreover, the interview guide helped the researcher to analyse and organise collected data (see Appendix 5-7). The number of interviews and their occupation was driven by the research conceptual framework and focus on testing four performance influencing factors – governance, risk management, access to finance and operational efficiency The interviews were recorded and transcribed. Names and companies have been omitted for confidentiality.

Table 3.4 List of interviews conducted with case study companies by occupation

CASE STUDY	INTERVIEWEES POSITION	INTERVIEW	TOTAL TIME (HRS)
CASE STUDY 1	Finance director	1	1
	Project manager	3	3.5
	Senior Trader	1	1
CASE STUDY 2	CEO	2	1
	Senior traders	2	2
	Logistics/Operations manager	3	3

	Finance	1	1
CASE STUDY 3	MD/Senior trader	6	7
PARTICIPANT 1	CEO, former trader, consultant	1	1
PARTICIPANT 2	Journal editor	1	1
PARTICIPANT 3	Account executive	2	1
PARTICIPANT 4	Senior Business Analyst/consultant	1	2
PARTICIPANT 5	CEO	3	4
	Senior solutions architect	1	1

3.3.2.2 *Case Study Interview Questions*

The aim of interview questions is to guide interviewees to talk about the most significant drivers and challenges of the upstream supply chains, efforts made to manage such challenges, expectations and perceived changes in the performance due to the use of DSS for different aspects of the commodity trading business. We also enquire as to the extent of DSS affects their communication/relationship with counterparties. Moreover, the semi-structured interviews aim to gain an understanding of what the company using the new DSS sees as performance improvement, how they measure it and whether they are able to obtain all the benefits possible from the use of the new application. Additionally, the interviews enquire about participants' understanding of the supply chain visibility and supply chain performance as well as company decision making. The list of questions in table 3.5 was used as a guidance and was adjusted for different participants.

The use of terminology in regards to supply chain challenges included supply chain disruptions, risks or events in the upstream supply chain which could result in a loss. The interview question protocols are provided in Appendix 5-7.

Table 3.5 Guide interview questions

<table>
<tr><th>NO</th><th>INTERVIEW QUESTION</th><th>COMMENT</th></tr>
<tr><td colspan="3">1. INFORMATION ABOUT THE COMPANY</td></tr>
<tr><td></td><td>General company information (size of company, number of employees, annual turnover); business structure and business units of the company, business activities</td><td></td></tr>
<tr><td></td><td>Sector characteristics – describe specificities of the commodity and supply chain you are in. What do you see as the challenges of the supply chain that might make you change anything in the way you operate?</td><td></td></tr>
<tr><td></td><td>Changes and developments in your supply chain

What do you consider the risks for your company in current supply chain conditions? How did they change over the last decade? What do you expect to happen in the next decade? What are the main controls do you have in place to manage those risks?

<table><tr><td>• Political</td><td>• Management risk perceptions</td></tr><tr><td>• Trading (price fluctuation)</td><td>• Operational (Delivery, storage)</td></tr><tr><td>• Economic (economic instability)</td><td>• Other (Food safety, complexity)</td></tr><tr><td>• Financial</td><td>• Relational</td></tr></table></td><td></td></tr>
<tr><td colspan="3">2. DSS USED BY TRADING COMPANIES IMPACTING COMPANY’S PERFORMANCE.</td></tr>
<tr><td></td><td>What were the main drivers for implementing a new system? What was the critical functionality for your business?</td><td></td></tr>
<tr><td></td><td>In your opinion, how does/will supply chain visibility and transparency impact your business? Do you think DSS help improve visibility across the supply chain? Does it help decision making?</td><td></td></tr>
<tr><td></td><td>How did DSS affect different parts of your business:

- Efficiencies (time spent on tasks, number of tasks completed within a day/month)
- Operations (Inventory management and control, on time deliveries)
- Risk management and managing uncertainty (related to 1.2 how did (whether) risk management policy change)
- Visibility across business and supply chain</td><td></td></tr>
<tr><td></td><td>How did DSS affect /make you change any of the processes in trading, shipping and logistics, accounts, etc. Did it improve your decision making?</td><td></td></tr>
<tr><td></td><td>What are the main performance metrics for you? Did you notice any changes in the company performance since you implemented the new system?</td><td></td></tr>
</table>

	What would you add to/change in your DSS?	
3.	**DSS AT AN INTERMEDIARY COMPANY INFLUENCE SUPPLY CHAIN PERFORMANCE**	
	Describe your relationship with other counterparts (based on trust, contractual relationships, collaborative, how)?	
	What were the main problems encountered in managing this relationship?	
	What king of strategies, if any, were adopted in order to overcome problems?	
	How much easier is it to manage these problems with the DSS?	
	Did differences in size of companies cause any difficulties? In which cases did you exercise your power (or experience it)?	
	How dependent do you do you consider your company is from other counterparty? What will be the consequences difficulties/termination in that relationship?	
	What is supply chain governance structure in your supply chain and how much it affects the way you work with your counterparts?	
	Do you think DSS bring any benefits to the supply chain?	
	In your opinion, did DSS help improve communication within the company? With your counterparties? How?	
	How do you think it helped reduce supply risk for your counterparties?	
	Do DSS help you streamline some operations with your counterparties?	

3.3.2.3 *Documentation Review*

The secondary data for the research was collected from the review of company archival data and current reports, including market reports, position/performance reports, valuation reports, project documentation, as well as internet-based and hard-copies of newspapers and journals, and videos. Documents are the source of evidence that cannot or hard to change, but can provide only limited view of the company operations as the sensitive information may not be revealed. The supporting documents and reports in this study are used to collect evidence about added value, costs, and operations management and performance objectives of the case study companies.

Table 3.6 Summary of data sources for the five case study companies

DATA SOURCES	OBSERVATIONS	INTERVIEWS	PROCESS MAPS	DOCUMENTS REVIEW
CASE 1	Complete during implementation process Oct/Nov 2015, discussion notes: daily activities of trade and logistics staff for 5 days. Project meetings – 5, training sessions - 5	5	Complete	Project documentation, internet background search, market annual reports
CASE 2	Complete during implementation process January-September 2016, discussion notes. Daily activities of trade and logistics staff for 16 days. Project meetings – 5, training sessions - 5	8	Complete	Project documentation, internet background search, market annual reports.
CASE 3	-	6	Retrospective	Background search, market annual reports
PARTICIPANT 1	-	1	-	
PARTICIPANT 2	-	1	-	
PARTICIPANT 3	-	2	-	
PARTICIPANT 4		1	-	
PARTICIPANT 5	Project review meetings, observations of dev process -	4	-	

3.4 Data Analysis

Qualitative research is highly descriptive especially when talking about social constructs and relationships between participants. Generally, social science research design implies that the outcomes of research are achieved through interpretations and reflections about gathered data (Flyvberg, 2001). The analysis of qualitative data has an interpretive nature; in order to achieve rigorous research results, coding of research results applied. This allowed identification of major themes and how they are shaped into patterns, and then further analysed through the concepts and theories used in the research (Yin, 2009). The process involves coding transcripts that allow for further comparison and analysis across the cases. The purpose of coding is to identify various types of supply chain challenges and risks experienced by respondents and to what extent they feel that DSS play a role in improving company and supply chain performance. The next step includes an in-depth comparative analysis of the labels from different transcripts in order to refine those labels from the coding. The final step of data analysis is cross-case and cross-respondent analysis of text pieces and labels. The cases were analysed 'within case' and 'cross case'. Every case study was analysed in-depth to develop explanations and details of processes and activities in all cases followed by cross-functional process maps. As the next step of data analysis – cross-case analysis was undertaken. This strategy improves the outcomes of one case to be used to predict those of other cases.

3.5 Summary

This chapter discussed research design analysing research philosophy, research methodology and research method. Multiple case study research design has been detailed and justified in regards to study purposes. This chapter described the different tools used to collect and analyse the qualitative data – semi-structured interviews, participant observations and documents analysis. The author believes that this methodology was the most appropriate for this research in order to better understand the phenomenon and develop conceptual framework to make contribution for both practitioners and scholars within the upstream supply chain intermediation field.

The following chapter will describe the case studies and qualitative data collected. It will also display the findings through 'before' and 'after' process maps.

4 Chapter 4 Case Studies

This chapter presents the findings of the three cases undertaken and provide thorough review of the company operations and drivers for adoption of DSS. The data collected through the means of semi-structured interview, on-site observations and informal conversations with key professional within organisations. The reason for gathering this data was to understand how intermediary trading companies operate within the context of upstream supply chains and the role of factors posing difficulties for intermediary companies in the supply chains that may affect the performance. The relationships with different groups of stakeholders in the supply chain have been also reviewed. This chapter aims to provide detailed review of the impact of DSS by means of 'before' and 'after' process maps. The chapter is followed by cross case analysis (Chapter Five) which sets foundation for the development of discussions (Chapter Six).

Table 4.1 CS Interviews Coding

CASE STUDY	INTERVIEWEES POSITION	ID	INTERVIEW	TIME (HRS)
CASE STUDY 1	Finance director	CS1I1	1	1
	Project manager	CS1I2 CS1I3 CS1I4	3	3.5
	Senior Trader (natural rubber)	CS1I5	1	1
	Senior trader and FX	CS1I6		
	Operations manager	CS1I7		
	Logistics manager	CS1I8 CS1I9		
	Logistics manager (Liquid commodities)	CS1I10 CS1I11		
	Director	CS1I12		
	Contracts Administrator	CS1I13		
CASE STUDY 2	CEO	CS2I1 CS2I2	2	1
	Senior traders	CS2I3 CS2I4	2	2

	Project Manager	CS2I5 CS2I6	2	
	Logistics/Operations manager	CS2I7 CS2I8	2	3
	Finance	CS2I9 CS2I10	2	1
CASE STUDY 3	MD/Senior trader	CS3I1 CS3I2 CS3I3	3	7

4.1 Case Study 1. Rubber Overview

The case study company is a Singapore-based company with subsidiaries in many countries across the world including the UK, Netherlands and the US. The company has gone through rapid growth via mergers and acquisitions over the past 5 years. The business focuses on a diversified commodities trade and is responsible for sourcing, storage and delivery of a wide variety of rubber and latex grades. The operational processes in the intermediary trading company involve activities that allow purchasing, selling and transportation of raw materials (solid rubber and liquid latex) to mills for further processing into consumable products (tires, medical gloves, etc.). The main operational requirements for the company include compliance with import/export regulations, quality assurance during transportation and, on the sale side, deliveries of goods according to specific time slots. The management and control processes in this sector involve activities that support price negotiations and marketing of goods, documents management, quality inspections and assurance and continuous stock valuations against market prices. The core decision-making activities centred around pricing, scheduling and allocations between customer requirements for qualities and manufacturing planning as well as suppliers crops and yields, as well as cost reduction and service suppliers selection (shipping lines, hauliers, trucking companies, etc.).

Table 4.2 Case Study 1 Overview

CATEGORY	COMPANY DETAILS
LOCATION	London UK (Singapore – head office)
MAIN ACTIVITIES	Dealers and Brokers of rubber commodities, wholesale or other intermediate products. Procurement, logistics and trading of natural rubber, including natural latex, synthetic rubber, polyisoprene rubber, polybutadiene rubber, butyl, specialty rubbers, rubber chemicals, accelerators, antioxidants, antiozonants, anti-scorching agents, and reclaimed rubber
NATURE OF BUSINESS (SIC)	46760 - Wholesale of other intermediate products 5199 - Nondurable Goods-Wholesale, NEC NAICS 424990 - Other Miscellaneous Nondurable Goods Merchant Wholesalers 3069 - Fabricated Rubber Products, NEC
COMMODITIES	Natural and Synthetics Rubber, Latex and Chemicals

ESTABLISHED	1998 (CMC 1919). Number of companies in the group 10 Ownership – Private Limited
NUMBER OF EMPLOYEES	13 (London); 50 (Singapore)
OP. REVENUE (TURNOVER) **PNL FOR PERIOD (NET INCOME)** **TOTAL ASSETS**	48 806 000 GBP (London) 1 129 000 GBP (London) 16 010 000 GBP (London)
PREVIOUS INFORMATION MANAGEMENT SYSTEM	Mercator; Navision Axapta (now Dynamics)

4.1.1 Information Management System Architecture CS1 'Before'

The company used a legacy system called 'Mercator' that allowed contracts, inventory and logistics management, as well as traditional reporting. The disadvantages of the system included, for example, rigidity in pre-set reports and tasks it could execute, lack of customised reports by user, and inability to conduct conversions between units of measures (MT into lb) – requiring a number of tasks to be executed outside of the system. Moreover, system was installed locally and the data produced in Corporate Performance reports could not be visualised or easily shared within the group of companies. Furthermore, system version became outdated and no longer supported by provider thus restricting opportunities for the upgrades of hardware and any other software applications that company would have liked to use.

> "*I find difficult to work with the very static way of reporting. We cannot create new reports and existing reports do not always match what we actually need. Unfortunately, not all raw data could be exported and even if we can, we have to create and design the reports every time*" (CS1I6).

The company accounts were kept in a specific accounting package and information on invoices and costs payments was entered manually by the accounting team members or by flat file import (CSV) and then manually checked by operators.

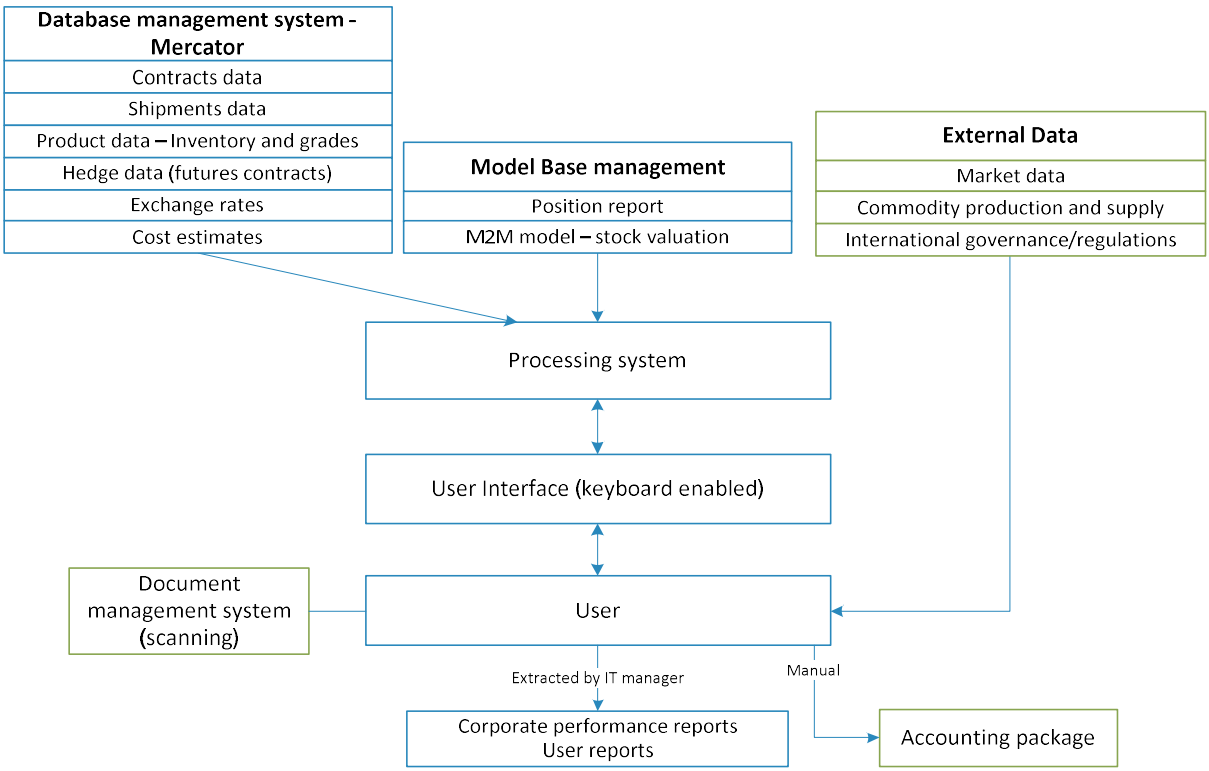

Figure 4.1 Information management architecture (CS1 "Before")

Due to the limitations of the system, it was maintained by administrative staff and not used for core decision making activities by the trading staff who relied on data manually extracted from the system. The data on market prices, production, consumption and demand of rubber is accessed by users from external sources. Moreover, any relevant documents created by the intermediary company (contacts, invoices, and shipping instructions) or received from customer, supplier or service providers (invoices, certificates of origin, bills of lading) had to be scanned and stored in designated document storage system. The details about company operations, policies and procedure are further discussed in sub-sections.

4.1.2 Company Operations CS1 'Before'

Rubber supply chains have been discussed in more detail in Chapter Two; the case study company occupies the position of a Natural rubber importer (see Fig. 4.2). The rubber trader is buying rubber or latex from the suppliers and sell the goods to small/medium-sized manufacturing companies (e.g. tyre producers) that are not large enough to have their own supply chain and procurement department.

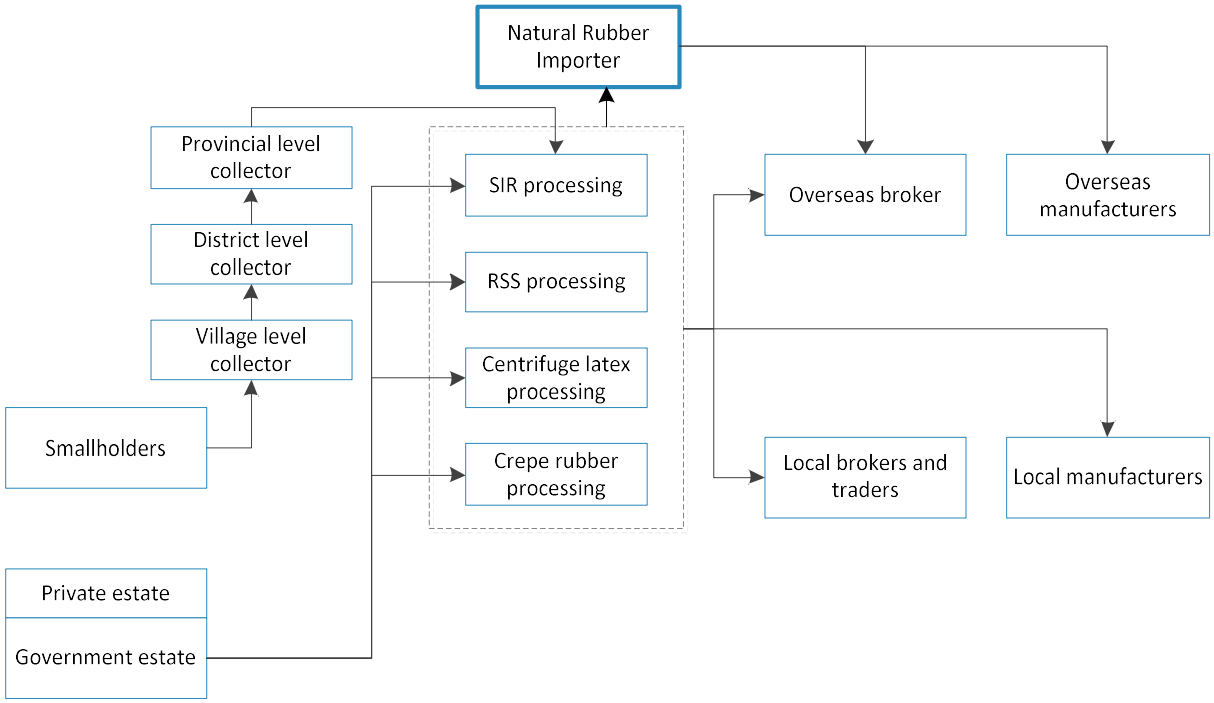

Figure 4.2 International rubber supply chain (adapted from Marimin, 2014)

Trading operations

The generic process of purchasing and selling can be described in several steps: sale/purchase trigger, requirements gathering, offer, record of purchase and documentation, and finally confirmation (see Fig. 4.3). The exchange of some emails can complete the entire process, but sometimes agreeing a contract can take many rounds of negotiations. The purchase or sale triggers can be events or factors such as favourable market conditions (market prices), current physical or futures positions ('short' – oversold goods or 'long' – overbought), availability or ageing of inventory, or other circumstances.

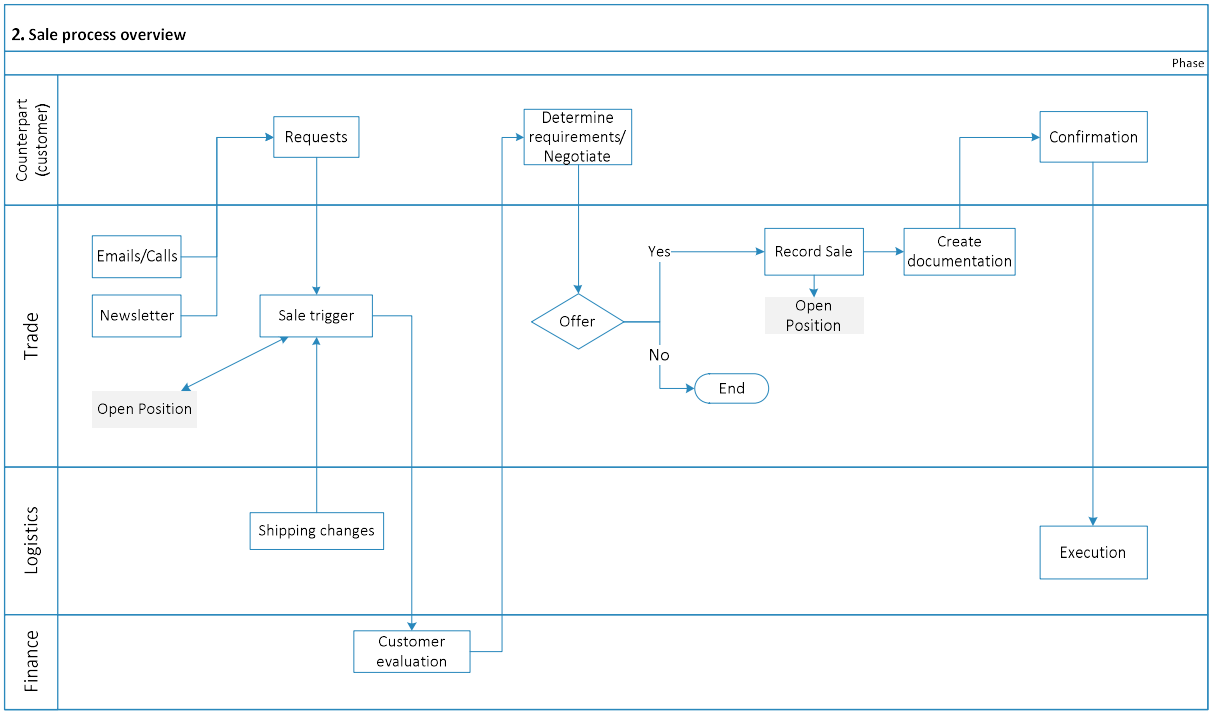

Figure 4.3 Sales process overview (CS1 'Before')

The decisions that are made at this stage are the most crucial for the business and the challenges include:

- Suppliers and customers selection, and their performance (e.g. quality of goods, delivery, contract defaults), political and economic situation of the regions
- Timing of the contract – shipping schedules and capacities (e.g. available warehousing/tanks)
- Financing of goods (whilst in transit) and cashflow
- Goods pricing and hedging to mitigate market volatility

The purchase and sales contracts compose a 'Position report' (or Position) which is central to the operations of the trading company. The report shows all the purchase and sales contracts issued by shipping schedule month.

> *"I use position report to check our physical and currency positions regularly, to decide whether we needed to do anything with our positions – buy or sell the goods and currency that we need or don't need"* (CS1I6).

The contract data and position report were updated in the system by designated staff member – 'position manager'. The report had a number of limitations with the speed of updates and flexibility of data displays.

Rubber Pricing and Valuations

The rubber pricing, as with many other commodities, depends on the origin and quality of the commodity, and on shipment of the goods via shipping lines. The factor that can be most disruptive and unpredictable is the dependence on market prices and the link to oil prices. Prices for synthetic rubber, especially, are directly linked to volatile global oil prices because it is produced from petroleum. Natural rubber traded on the SICOM futures exchange doesn't have a direct relationship with oil prices, but is still affected by them. However, lately, the price fluctuations have been described as "*not following the fundamentals of the market trade*" (CS1I2). The value of goods purchased or sold but that have not been shipped are continually reviewed against those market prices

Another factor associated with changes in value of rubber is the location of goods. It is assumed that the change in location to the warehouse increases the value of rubber. For example, CNF US East Coast rubber is higher priced than FOB Far East rubber. This difference in price is due to the more convenient location of goods for the final customer.

> "*We use a designated spreadsheet to value the position periodically during the month, this allows us to make price projections over 24 month's period*" (CS1I2).
>
> "*The price valuations are done monthly due to the time consuming process of updating the spreadsheet*" (CS1I5).

Costs is next key factor for goods valuation and pricing. The costs are mainly attributed to the sale price (incorporated into sale price of goods). The main costs that a company incurs include ocean freight, inland trucking, storage costs, insurance, bank charges, demurrage, specific packaging charges, off-loading and loading costs. The margin between purchase and sale price is generally very slim so costs management and suppliers' assessment is key for business. Getting all the cost data into the system have been difficult for the company.

"*It's important to get a view of costs on a shipment or contract in order to make a good comparison to the calculations in the sales contracts. Preferable have the system make that calculation*" (CS1I7).

"*So many of our contract costs are wrong and we need to start correcting them, but without some standard matrices that will be a nightmare*" (CS1I12).

Allocations' Consolidation

Allocation is a term in trading used to describe the process of linking purchased goods with sold contracts. The process and decisions related to making allocations is different between companies, but in this case, once a match between purchase and sale contract has been done, the profit and loss is actualised and contracts are removed from an open position. The trigger that drives the allocation process is sales – the obligation to deliver rubber as per contract, and customer-supplied schedules determine when and what gets allocated.

"*The lack or unavailability of contracted grades of rubber might mean that additional purchases need to be made, the data should be up-to date and ready available to make that decision*" (CS1I5).

The process of allocations can be effectively managed with appropriate reports and accurate data. Whilst managing a current shipment period, traders are always looking into future positions for possible long and shorts. The company commonly relied on the experience and knowledge of the trade staff to make allocation decisions.

"*Finding appropriate matches to conduct effective shipments requires knowledge and experience. Knowing the customers and understanding their requirements and limitations is important in matching purchase contracts to sales*" (CS1I5).

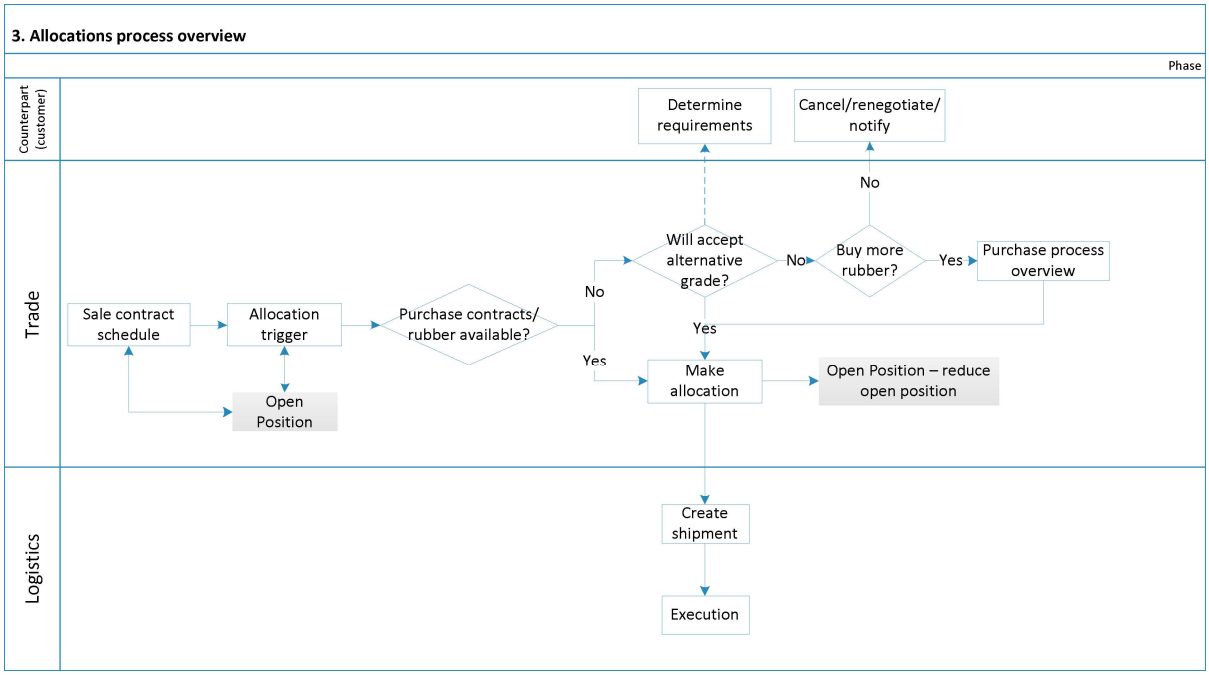

Figure 4.4 Allocations process overview (CS1 'Before')

Shipping and Logistics Operations

There are four different shipment types that a company undertakes:

1. B2B (back-to-back) shipments directly from supplier to customer
2. Stock shipments into a warehouse near to potential customers or company-owned warehouses
3. Transfer shipments between warehouses
4. Delivery shipments from warehouse to customers

Once the type of shipment has been determined (allocated to sales contract or not) and the decision has been made as to the destination of goods, the shipment is created. These two decisions rely on accurate information in position report and inventory reports that need to be readily available at any point in time to determine the capacity and space availability in warehouses or tanks.

Another important decision concerns the means of transportation and use of shipping agents. Depending on the purchase contract this might be done by the seller (Incoterms), but more often done by the trading company to keep control of the costs incurred. The changes in shipment industry, freight and cargo deliveries affect the business. The shipping industry is

more competitive and allows for much lower prices, but additional time is required for review and negotiations with multiple providers for the best rates. Trading intermediaries negotiate monthly or quarterly rates with shipping lines and the decision is made based on a cost versus quality of service basis. Shipping rates are one of the most important factors in managing the margin between purchases and the sales a company makes. Some reports were not available in the system and had to be done outside of the system.

> "*We monitor much tonnage we are shipping with our freight forwarders and/or shipping lines and require good overview to see how much we have booked or shipped during a certain time*" (CS1I7).

The issuance and receipt of shipment documentation is the next crucial part of the business because it identifies the transfer of ownership of goods to an intermediary. The documents describe what has been shipped in terms of quantity and quality. Documents are necessary for customs clearance and then are used as part of the sales process. Business depends on this part of the process - accurate and on-time delivered documents can speed up or greatly delay shipments. The information on shipping documents like BL numbers, marks, weight packing and warrants stay with the inventory throughout the sale to the customer.

> "*Documents management is a bread and butter of the business*" (CS1I3).

The documents need were scanned and stored in electronic document management systems. The shipping and documents consolidation process is combined in Fig. 4.5.

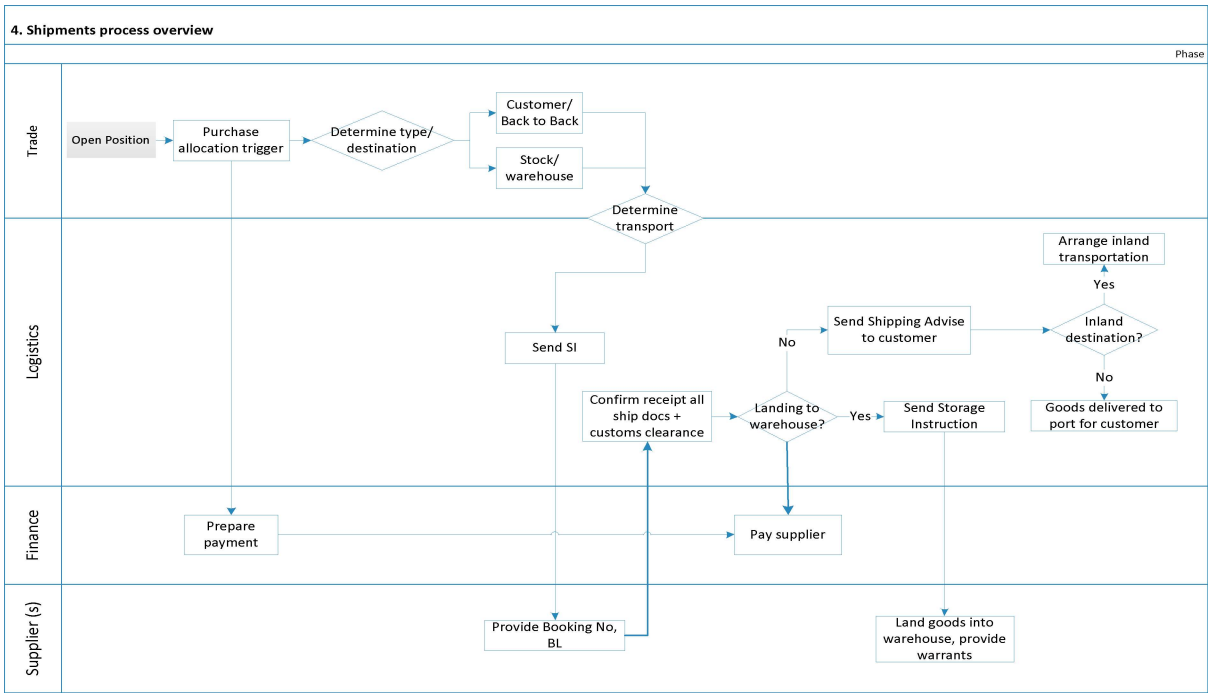

Figure 4.5 Shipping process overview (CS1 'Before')

Depending on the actual terms of the purchase contract, the payment may occur earlier in the process (pre-payment), but generally depends on the acceptance of the documents by the trading company or ultimately customer in the case of B2B shipments. Accurate documentation also affects the speed of payment and can affect cash flow. There was a need to improve document accuracy and turnaround efficiency.

Deliveries to Customer

The process of delivery of goods to customers has been included because it involves some specific value-adding features. The Delivery Order is a document issued prior to the delivery of goods and signifies the process of the delivery of goods. It does not affect the position or impact open purchases or sales contracts, but leads to the issuance of a sales invoice which concludes the purchase cycle. This step converts inventory into accounts receivable that are then reported as actualised profit or loss.

The customer deliveries should satisfy customer specific requirements in terms of product packaging, marks, documents or delivery time slots. These are crucial for meeting customer expectations and satisfaction. The delivery order includes all the information available about

the goods starting from purchase contract numbers, shipment numbers, warehouse release numbers and any relevant customer references.

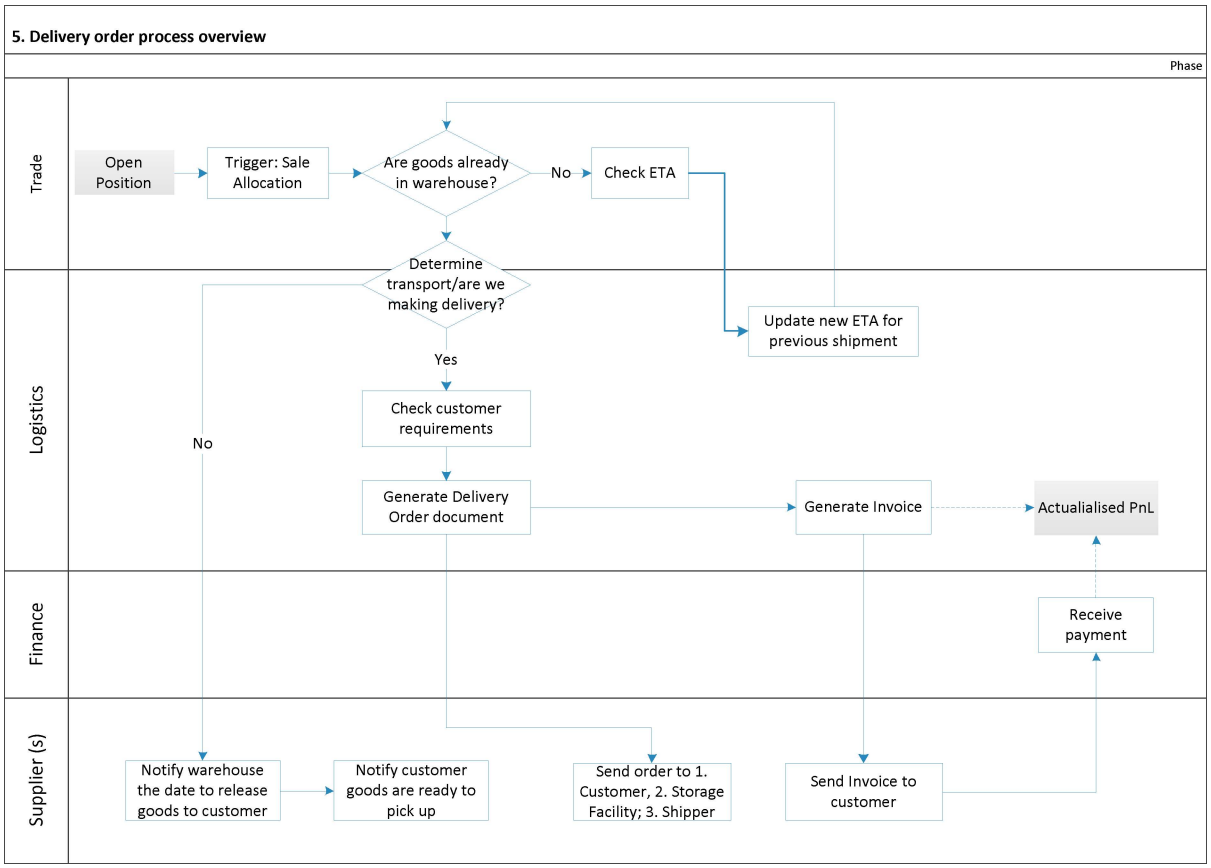

Figure 4.6 Delivery Order process overview (CS1 'Before')

4.1.3 Supply Chain Governance CS1 'Before'

The main partners upstream and downstream in the supply chain as well as supply chain governance have been also discussed in Chapter Two and summarised in the diagram below.

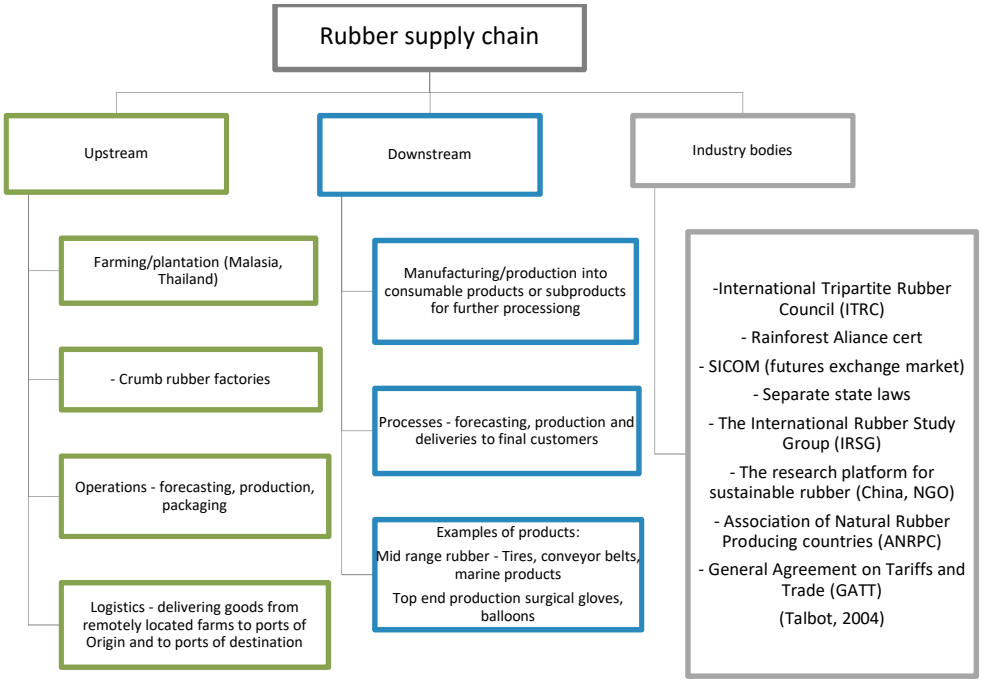

Figure 4.7 Rubber Supply Chain Governance

As with other commodities, compliance with the state and international rules and regulations. Sustainability, traceability, and corporate social responsibility have become some of the most important factors for the business that is sourcing goods around the world. The case study company has developed the Corporate Code of Conduct – group policy with regards to child labour, anti-discrimination, and responsible sourcing of goods. The document is provided on customer request. The suppliers are reviewed (surveyed) as part of company due diligence procedures.

> "*We require robust traceability process of the quantities and qualities purchased and sold and written off or lost*" (CS1I12)

The information that the company stores about goods and suppliers provides the means to trace back the origin of goods sold. However, liquid goods like latex can be easily blended together in one tank and lose their original characteristics. The information transportation and storage of about liquid commodities have to be managed outside of the system as well.

4.1.4 Risk Management Policy and Procedures CS1 'Before'

The company's risk management policy was continuously revised and focuses in three main areas. First of all, contracts' market exposure is reviewed – how many contracts have been hedged against the futures market exchange; market price changes; basis changes – market prices on different futures exchanges. The Singapore Commodity exchange (SICOM) is a major commodity exchange for rubber and coffee. There are two types of rubber futures contracts that are listed on the exchange – RSS3 – latex and TSR20 – natural rubber. This allows traders to use such financial instruments to hedge market risks against their physical contracts up to 2 years in advance. By buying and selling futures contracts they are able to manage their margins and revenue streams by locking in a fixed price. The traders are required to consider the amount of goods to buy to match the expected demand. Transactions with paper contracts have been also recorded outside of the system in the designated spreadsheets. The risk management tool that helps manage and review market prices fluctuations is called Mark to Market (M2M) - marking physical position against the market prices to review the current value of goods.

Secondly, customer exposure is monitored by considering the amount of goods sold per customer or bought from suppliers and setting basic trade limits. This data was kept within the accounting package and outside of the operational system restricting the visibility of the limits when making new contracts with suppliers and customers.

Thirdly, number of shipments/goods currently afloat. The specific risks include loss of goods in transportation, storage, and delays; quality assurance; changes in costs. Some of these risks are mitigated by insurance for goods and shipments, but majorly depends on accurate and timely information that allow informed decisions to be made. Long-term agreements are used in relationships with other service providers in the supply chain too – warehouses, insurance companies and inspection companies. The company negotiates yearly or quarterly rates for insurance rates or storage rates. Finally, relationships with shipping lines are some of the most difficult to assess because often there is no specific relationship with shipping lines on rates. The company is trying to negotiate yearly rates, but freight rates change bi-weekly, moreover they do not always provide good transparency of their bookings especially when goods are being transhipped and executed by partnering shipping line. The selection of shipping line is

generally based on best rate and a decision is made based on a trade-off between quality of services and shipment rate.

> "*We tend to choose lowest rate which is generally not very high quality service, but because margins are so narrow, that's where we compromise. We are sort of at their mercy*" (CS1I3)

Some upstream commodity supply chain risks are particularly hard to manage: the global economic situation, political and war risks. The mitigation approaches here rely on building relationships and conducting due diligence with the partners. Long-term contacts with customers and suppliers are used to mitigate demand and supply uncertainty. This builds partnership to secure long-term supply and safeguard from unexpected supplier default. As for customers, some key long-term agreements include consignments whereby keeping the stock owned by trader in the customer's warehouses to reduce liabilities. These factors have been managed outside of the information system used.

Careful monitoring of the customer and supplier performance is also a requirement from ISO certification. Reliable systems that store the information on all the counterparties helps in auditing.

4.1.5 Access to Finance and Company Performance Management CS1 'Before'

The relationship with Bank(s) has its special characteristics and agreements continually reviewed. The companies agree credit lines for financing operations under receivables and inventory (e.g. physical assets as collateral) and require to report weekly on the warehouse location of goods and inventory in transit to keep credit lines open. Banks carefully review the company performance and risk management strategies to increase or reduce amount of credit provided. The company identified several operational and financial performance metrics used described below.

- 'Accounts past due' – invoices that have not been paid by customers before the invoice due date. Delays in payments generally highlight that the shipment of goods did not arrive on time or that the customer did not make the payment on time. Delays in shipment may occur due to numerous reasons such as shipping documents not

being in order, shipping line delays and late offloading from the ship to name a few. Customers can delay payments due to financial problems they might have. In practice, 'accounts past due' is a good indication of how the company performed on a monthly basis.

- 'Inventory ageing' – company stock in warehouses by number of days/months/years. This metric shows how much of the 'old' inventory is on the company's balance sheet and that needs to be sold. The target is to ensure that inventory is not stored in warehouses for longer than one year due to bank credit line regulations.
- 'Missed deliveries' – late pickup of goods by trucker (inland transportation) from port of destination to warehouse. If the goods have not been picked up from the port on time, extra charges for demurrage are issued that increases overall costs for the shipment of goods.
- Yearly performance - year on year analysis on volumes of goods traded, margins and realised PnL (Profit and Loss).

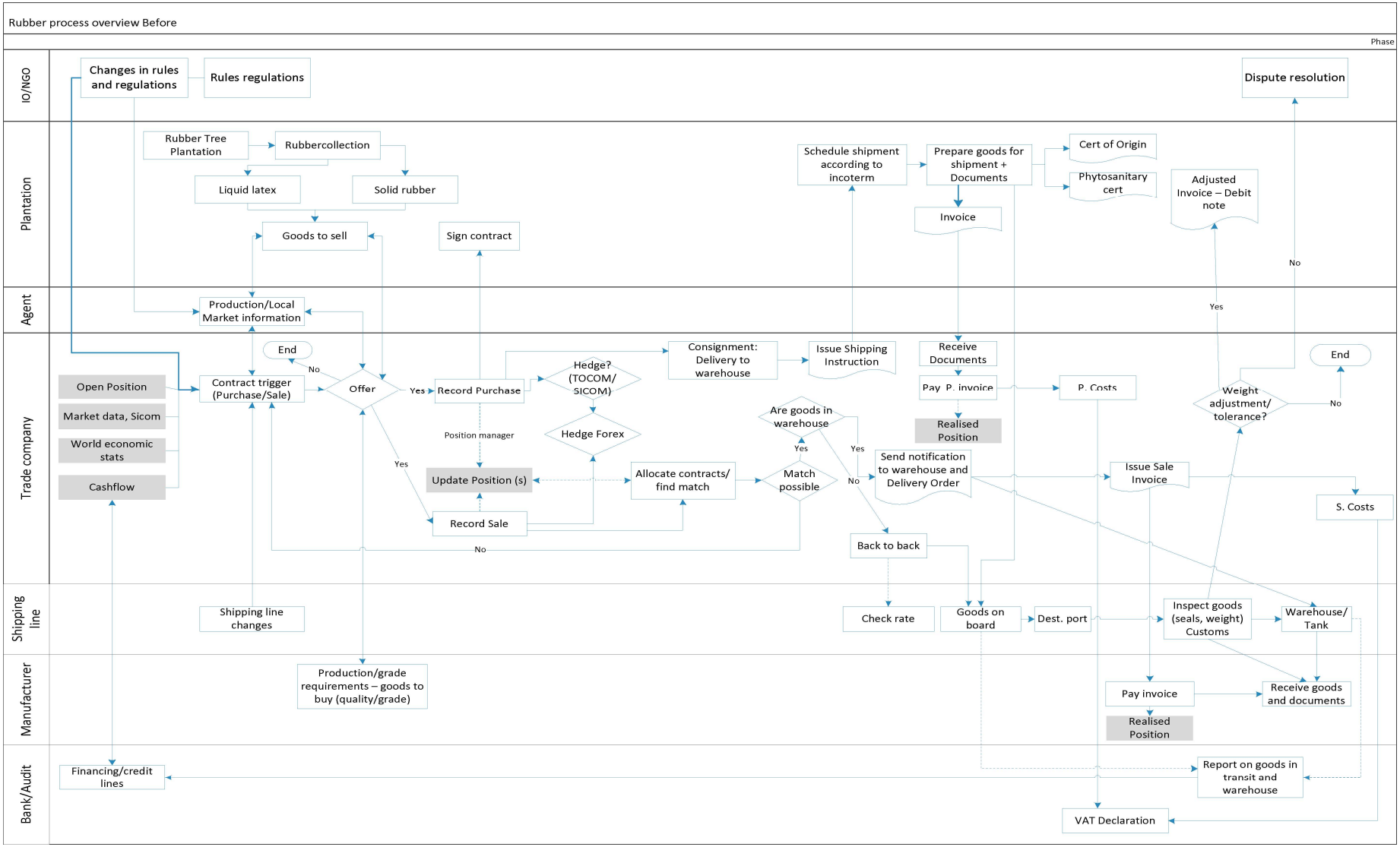

Figure 4.8 Rubber trading process overview (CS1 'Before')

4.1.6 New DSS Architecture CS1 'After'

This section reviews the changes introduced with the adoption of DSS. The brief description of the implementation project presented, followed by the 'After' process maps of DSS and company operations as well as the impact on the four main challenges reviewed.

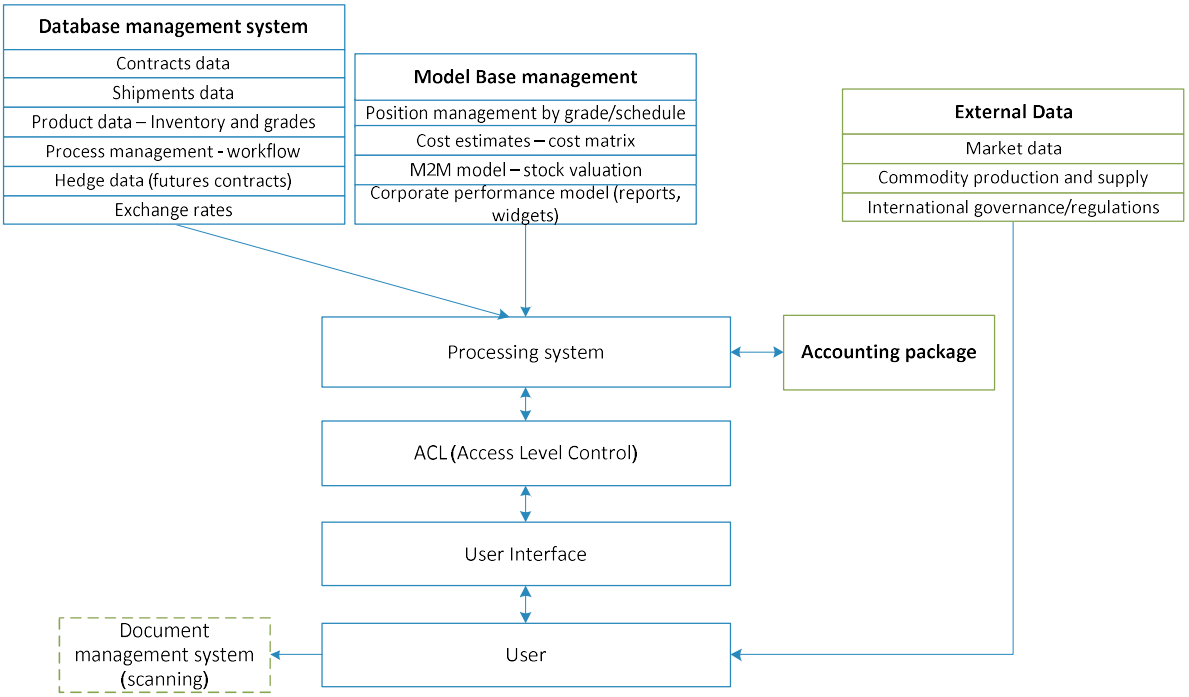

Figure 4.9 New DSS Configuration model (CS1 'After')

The new information system architecture is presented in Fig. 4.9. The 'position report' in the new system provides more up-to-date and comprehensive information and allows to break it down by different categories – origins, grades, schedules, locations of goods, etc. Corporate performance reports have been defined to review company performance at any point in time, but user specific searches and reports could be done in the system without any external assistance. Process management workflows modules have been introduced to set the points in the supply chain and business processes that the company would like to track such as issuance of shipping documents or recording of physical location of goods during transportation. The transfer of data between the trading system and accounting systems was facilitated by a two-way integration so that the trading system can send information to the accounting package and then pull relevant data to the trading system from the accounting system. Live data or close-to-live data is very important for timely decision making. The

system also reduced many manual tasks such as conversions between units of measure, documents and emails generation.

New DSS Implementation Project CS1

The search for a new supply chain management DSS was driven by the ageing Mercator system. The system had numerous limitations as discussed earlier in the chapter. The first effort to upgrade/change the information management system in the company was the Navision Axapta platform. This platform did not have a specific commodities' module which had to be specifically developed. The implementation was unsuccessful due to an inability to re-produce reports that were required for the risk management of the commodity trading company. The failure of the implementation encouraged the company to better define its processes and system needs.

The selection criteria for the information management system included:

- Web-based/ cloud-hosted application – ability to log in from anywhere in the world and an overview of global operations of different locations and companies within the group
- Multi-commodity application – solid (rubber) and liquid (latex) commodities
- Budget – investment into large ERP application would have required additional costs to build specific functionality to handle commodities trade; were looking for medium-sized package.

When the new DSS vendor has finally been selected, the project of implementation was scheduled. The project included data migration of some historic data and all current company contracts, shipments and invoices; assessment and development of any gaps in functionality found; system set up and customisations of user interface, reports and company workflows; user training; and finally parallel run.

An important part of the implementation included integration between the accounting package used and the new trading system to establish automatic data interchange and finalise comprehensive data architecture. Integration via web services was chosen. Both systems have customer and supplier databases as well as sensitive invoice and valuation data. The

systems had to be 'talking to each other' to ensure data integrity and further reduction of manual errors. Additional functionality had to be added to allow for company contacts to be posted back from the accounting package (master database for customer details) and master data for contract, invoice values.

The project took about 6 months including a 4 week break for year-end reporting needs and went through a number of iterations for additional features to be added. The company started using the new system in May 2015 with a target to develop additional system features in the future.

There were a number of core changes introduced during implementation from the way users interact with the data, to terminology and process descriptions. User friendly and easy-to-understand pages were recognised to be more engaging for the staff and encouraged to learn and use the system by traders as well as administration and logistics staff. Another significant change was the workflow functionality and placeholders for additional information such as multiple ETS and ETA, tasks, deadlines, documents. Furthermore, the new platform allowed the creation of custom reports based on specific searches. People used to rely on pre-set reports or had to ask IT support to generate a specific report for their needs, now the system allows them to create any report they need themselves. This is a change in thinking, tasking and reporting.

The changes that have been introduced during the implementation period reduced employee efficiency and the learning curve for the new system took longer a time than originally anticipated. It was then recognised that the process introduced positive changes in user behaviour.

> "*People are beginning to appreciate 'self-service', but the system allows so much flexibility that user learning was a long process*" (CS1I2).

As a part of software-as-a-service (SAAS) approaches agreed with the information systems vendor, the company are still hoping for continuous development and improvement of functionality. The plans include "making system more comprehensive" - finalising documents storage and management through single platform (removing Document Management system and scanning), finalising two way data feed between the accounts package and the commodity management system; building a set of reports to view 'global position' whilst

maintaining separate books; intercompany facilities and dashboard; shipment PnL and costs analysis – where the company is losing money need formatting.

4.1.7 Company Operations CS1 'After'

The main changes in operations are summarised below.

Managing costs and evaluation of various shipping rates are some of the crucial responsibilities of the logistics department – finding new ways to manage costs, registering costs and generating cost of sale.

> "*Operational cost matrix that will enables us to auto estimate costings in a reliable manner and then compare estimates to the actual costs paid*" (CS1I10).

The company has increased number of cost types to monitor and account for the even small amounts (such as daily storage costs per kg/MT) that might affect the profit margin:

> "*We've set up all these cost types in order to better monitor on which item we are making a profit or a loss*" (CS1I17).

In regards to managing inventory management, it is generally recognised by the company that the goods have a higher value if they are sold from the warehouse – more convenient location to the customer and some company data suggested that recently the amount of good stored in the warehouse increased (see Fig. 4.11). However, interviewees could not make direct a connection between the new information management system and the inventory management approach. The visibility and precision that it gives the company helps to see the location of goods and number of days/months it has been at the location.

> "*We have a tighter grip and control over inventory, but cannot say that we changed anything in the way we manage inventory*" (CS1I2)

As for the process of allocating goods between purchased goods and sales obligations, the case study company did not want to introduce any major changes:

> "*Allocations process cannot be automated because they do not want the freedom of decision to be taken away from traders*" (CS1I12).

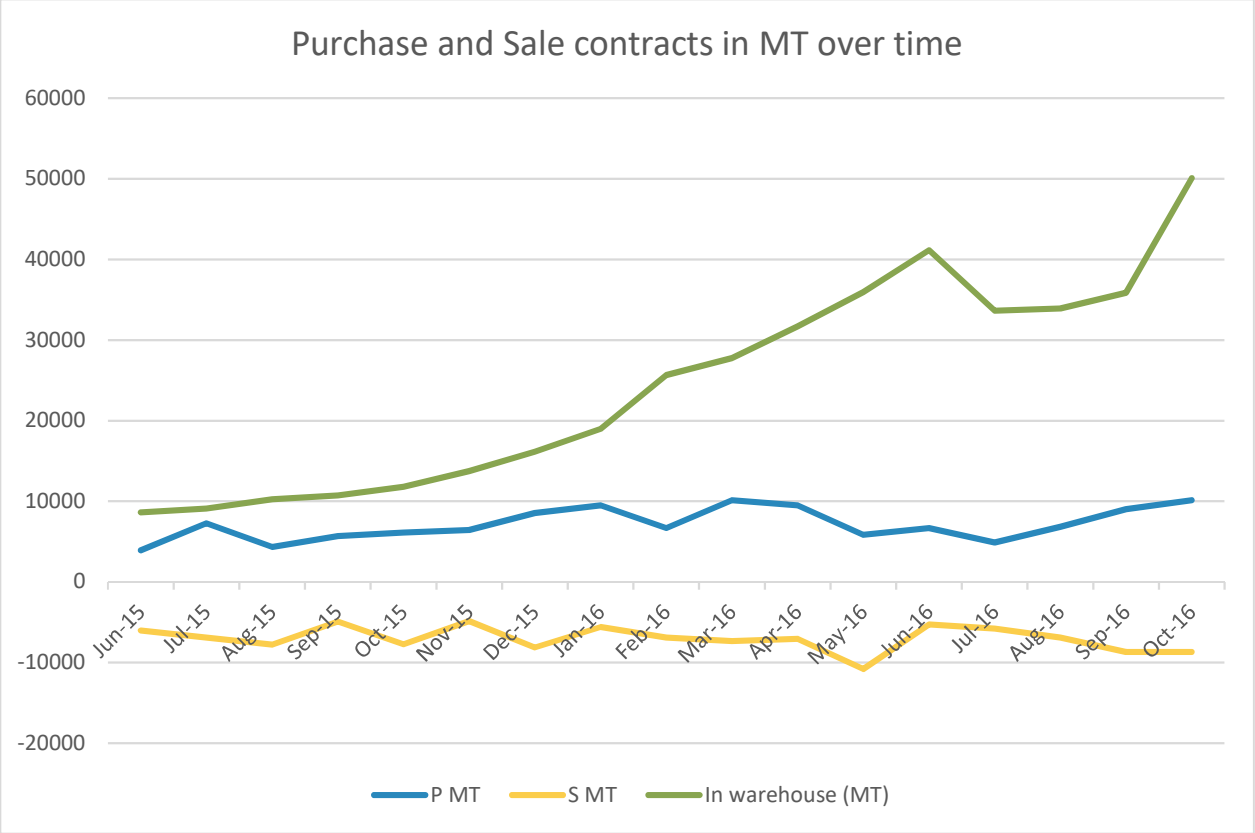

Figure 4.10 Stock in warehouse over time

The process of executing shipments and document generation have become more streamlined – issuing documents via emails, generating documents from the system and reduction of human errors. The specific document management system can be completely substituted over time.

> "*Document generation help our efficiency and control greatly across the group, for example attaching supporting documentation such as proof of delivery to an email from the shipment*" (CS1I3).

Moreover, ability to set the workflows and monitor the time taken between the actions provide the company greater insights into their operations and possible bottlenecks.

> "*Ability to check the number of days between Final Received & Approved date of the documents (especially B/L) could be a meaningful KPI for the logistics department. Another report we are planning to use is originally planned date of delivery/arrival versus actually realised date of delivery/arrival for evaluation of supplier performance*" (CS1I17).

Another change that impacted the company efficiency is the integration between the accounting package and the trading system via web service instant connection, two-way communication between systems allows direct posting of invoice data and returns the payment status of invoices. This also allows company to view and analyse the efficiency of the customers and compliance with payment terms.

Internal communication and coordination within the organisation have been found to improve. The factors highlighted include data cleanness, record edit histories, and internal comments that allow for easy information access by stakeholders within the company. Additionally, the company benefited from single information management point. The staff are more task-oriented following the specific "to-do" lists from the system.

> "*It is now easier to investigate what has happened to specific contracts and shipments and answer their own questions*" (CS1I2).

4.1.8 Supply Chain Governance CS1 'After'

The changes have been observed in the processes including new controls in the management of contracts with the new information management system. First of all, the company had a specific role – 'position manager' who was responsible for the entry of purchase and sales contracts into the trading system and administration of allocation task between purchased and sold goods in the system. The presumption was that the traders should not be doing administration for the contracts and look after more "*business value adding tasks*" (CS1I4) such as negotiations and communications with the customers. However, in the new DSS traders enter the sales contracts into the system. This change has split opinions within the company. On the one hand, the trader's judgements and accuracy of the information entered have been questioned. For example, cost estimates are entered at the contract level because they affect the final sale price of the goods. The lowest cost levels can be entered in order to show higher margins and better trader's performance. If the contracts are entered by an independent person, the costs are more rationalised. It was found that the new structure created a better sense of responsibility of the entire process by the trader – from administering contract entry to the system to ensure that the invoices have been paid.

Moreover, overall business visibility improved which contributed to the better internal coordination and visibility behind decisions made.

Moreover, the new DSS allowed to establish step by step processes (workflows) and set up controls for shipment and logistics operations - tasks and documentation; as well as inventory controls - locations of goods, quality, origins and transformations (liquid latex). These factors allowed to streamline the processes and improve internal coordination which are attributed to the transactional governance by the company.

Additionally, the case study company recognised the role of DSS in addressing the need for traceability of operations in supply chains to show commitment to the sustainability efforts.

> "*There are thousands of rubber trees and some consumers can request rubber from a specific tree and from a specific producer. The track and tracing capabilities of the DSS are crucial for the future existence of the company in the supply chain*" (CS1I5).

The suitability requirements are driven by the consumer and the business complies with the global movements against child labour and modern slavery. Even though these efforts are still in their infancy, it is the future of rubber commodity trade. The company made efforts to track times and dates that goods added to tank and taken out of tank in order to trace back the origin of goods that have been in the tank during specific periods of time.

Finally, the data that became available in the new systems allows for controls over the performance of the supply chain partners – suppliers, service providers and customers. Ability to make analysis over the payment delays, errors, etc. improves company contractual governance.

4.1.9 Risk Management Policy and Procedures CS1 'After'

The position report is a core tool for a trader to make decisions on buying or selling the goods and prices for those goods. The new DSS allows for a close to real time position report that gets updated with every new trade entered and shows company exposure to market risks of hedged and unhedged contracts. The precise information on recent price movements and available goods in containers by their location enable making the decision quicker. The information is then centrally available for all traders and the executive board for review.

Additionally, the information can be broken down and viewed in multiple ways including company position by grade – amount of goods bought or sold of specific grade and make a further analysis.

> "*The system gives us more accurate reflection of current position and location of goods. You want as much real time as possible to make trade decisions*" (CS1I5).

The new reports and improved position management helps executive board make better informed strategic decisions for the entire group. Access to live position and allocations allows for better visibility of all operations and assessment of the company overall exposure by supplier and customers as well as shipping agents and ports of shipments. Additionally, the cloud application and login from anywhere allows for more flexibility for the business in dynamically changing market conditions.

> "*The company maintains a database of customers, suppliers and service providers, and defines trade limits with them. Moreover, partners' performance is reviewed based on number of days they process payments, timeliness and accuracy of shipping documents and deliveries of goods for example*" (CS1I5).

Another information management feature recognised to positively affect company risk management is the stock valuation model. A 'Mark to Market' report allows the calculation of the value of goods based on current market price and any other price adjustments such as quality premium or convenient goods location. The report was done monthly due to time taken to produce this report. The new system allows the re-evaluation of goods at any point and the company established a more regular weekly valuation task. This leads to more accurate and un-biased presentation of the company's performance.

> "*A specific spreadsheet format for the adjustment prices that we could use for upload to the system was developed to make valuation process faster*" (CS1I2).

The visibility provided by the system allows to better understand the reasons behind the decisions made by the trader who typically relies on the personal judgement and intuition.

Risk management for the customers is a core capability for the business and the reason why companies choose to buy goods from them rather than directly from their origin. Reliable data and visibility allows the maintenance of risk management at a high level:

"*We had a customer who decided to start managing their own rubber supply chain and sourcing. This required them to hire new staff, go through a great learning curve and ended up in increased frustration for the management of shipments/container loads, etc. In the end, they decided to come back to the original supply chain management approach through an intermediary, reducing stress and uncertainty for their business*" (CS1I3).

Various factors then help the company to make a decision to 'go short' or 'go long' in their open position, but they primarily rely on the current financial and market situation to decide to sell forward at a high price (go short) or buy more stock if the prices on the market are going down (go long). As shown on the diagram below (Fig. 4.11) created from company contracts data over 17 month period, the company took a distinctly 'short' position in August 2015 and May 2016, but in January 2016 and June 2016 the company decided to take a 'long' position. Moreover, risk assessment includes reviewing the global position for the entire group in order to make a judgement on overall company position.

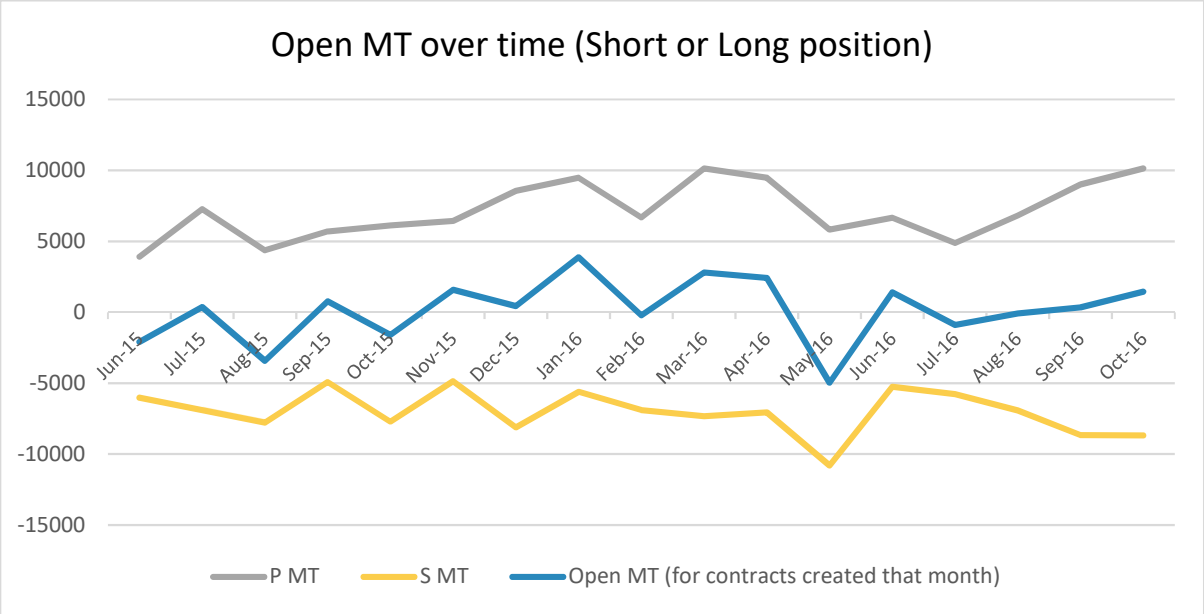

Figure 4.11 Open Position over time

The quality of goods is another common concern in upstream commodity trade. Conflict materials and quality claims are cumbersome and lengthy procedures which can impact on company cash flow. Comments and remarks for clients and goods are commonly used.

4.1.10 Access to Finance and Company Performance CS1 'After'

Warehousing and financing of goods whilst in the warehouse is one of the important value-adding activities of the company. In order to maintain credit lines opened with the bank(s) the company is required to produce weekly reports on the location of goods in the warehouses and in transit. The inventory older than a year in stock cannot be used as collateral. The inventory has to be insured to count for credit relying on accurate reporting from the trading system to do that. The credit lines and terms are agreed yearly and compliance with bank regulations is key.

> "*The world financial crisis of 2008 had a big impact on our business, the credit market collapsed and the company lost its credit lines and was not able to insure goods. Credit lines affected receivables 3-6 months old which were still bought at a low price, then the price rocketed and we got 'pinched' on cashflow. It was difficult to navigate through that time, uncertainty for prices, but also if any of the suppliers or customers default on the contracts because customers were losing their credits too*" (CS1I2).

The banks need to ensure continuous and reliable performance of the intermediary trading companies. The data in the system and pre-set report allows for efficient exchange of data between the trading company and bank.

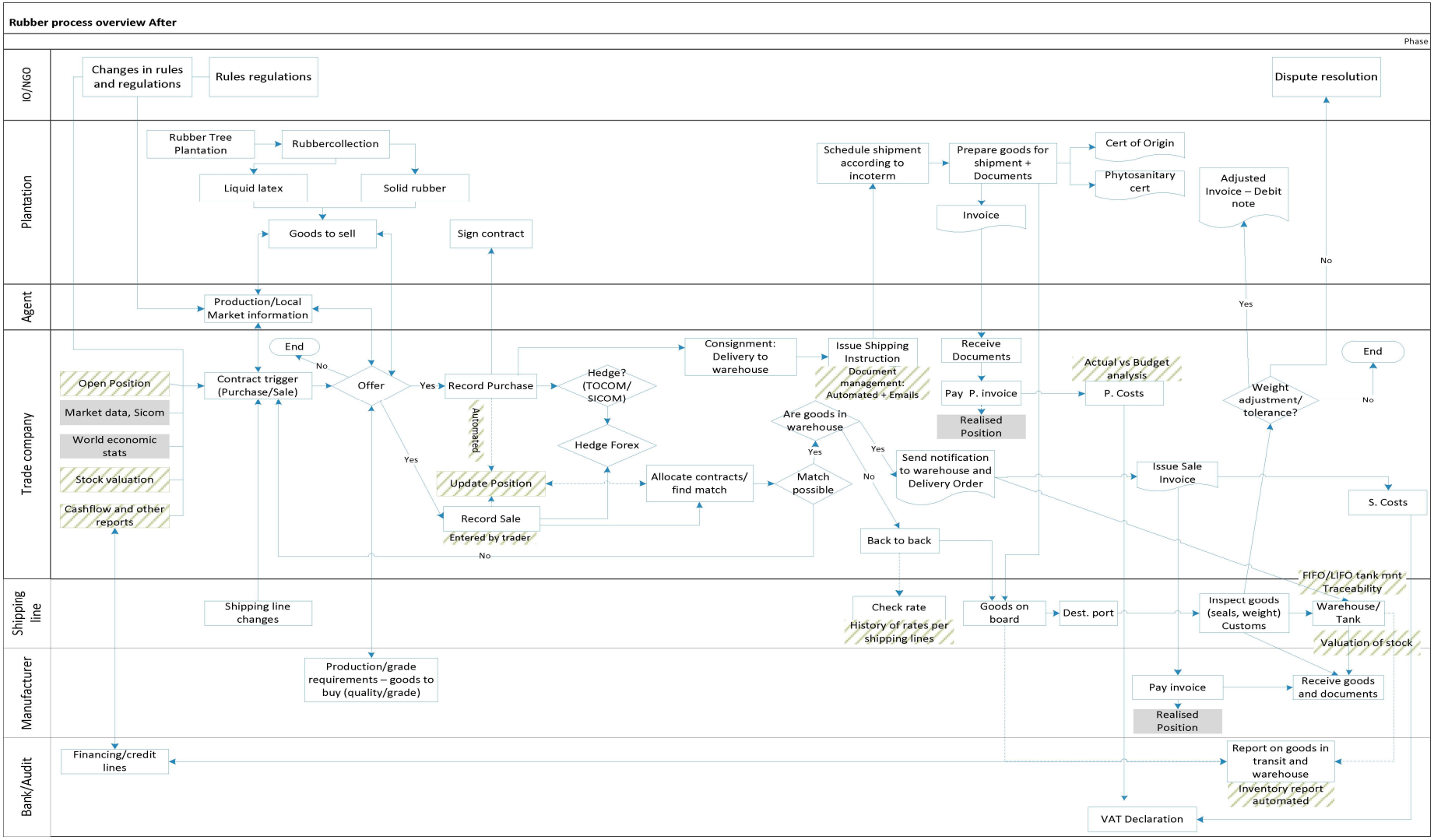

Figure 4.12 Rubber trading process (CS1 'After)'

Table 4.3 summarises the case study funding from the analysis of data from the interviews, observations and process maps completed.

Table 4.3 Case study findings (CS1)

	'BEFORE'	**'AFTER'**
GOVERNANCE	Lack of tracing capabilities Drive to implement better controls for the processes	1. Transactional governance – process coordination and streamlines procedures; 2. Contractual governance – controls and performance assessment of SC stakeholders 3. Supply chain governance – traceability systems
RISK MANAGEMENT	Position report that required manual updates/manipulations Monthly valuation of goods	1. Real time (close to real time) Position 2. Position break down by grades/location/etc 3. Standard corporate reporting across the group 4. More regular - weekly valuation process
TRADE FINANCE (ACCESS TO FINANCE)	Time consuming reports Lack of functionality to trace amount of time goods stored in warehouse	1. More accurate and quicker reports to bank 2. Monitoring of ageing inventory (not older than year)
OPERATIONAL EFFICIENCY	Limitations for data entry opportunities Un-flexible reporting/lack of analysis Time consuming entry	1. Cost management and analysis (e.g. Actual vs Budget) 2. Inventory accuracy 3. Automated documents generation 4. Improved internal communication

4.2 Case Study 2. Coffee Overview

The case study company is a UK-based small/medium-sized company with less than 20 employees. The company has been established since the 1970-s with the goal to deliver high quality specialist coffee to the UK. Current company operations include sourcing, marketing, deliveries, storage of green coffee beans from exporters and farmers, and distribution downstream to mainly British-based coffee roasters. The main purpose is to ensure that the quality of products traded are up to level agreed with suppliers and customers. In addition, the company ensures thorough inspections for moisture, chemical stains and foreign odours and conduct their own coffee tasting (cupping) and further quality certification services. The distribution of goods to the customers are classified into 'warehouse release' and 'delivery orders'. The major functional activities also include marketing of certified coffees, approaching and developing supplier bases at the origins.

Table 4.4 Case Study 2 overview

CATEGORY	COMPANY DEATILS
LOCATION	London, UK
MAIN ACTIVITIES **NATURE OF BUSINESS (SIC)**	Sourcing, trading, storage and deliveries of regular and specialty green coffee. 46370 - Wholesale of coffee, tea, cocoa and spices
COMMODITIES	Regular grade coffee, specialist and gourmet coffee
ESTABLISHED	1970 Ownership: Private Limited
NUMBER OF EMPLOYEES **OUT OF WHICH TRADERS** **LOGISTICS**	17 5 4
OP. REVENUE (TURNOVER) **PNL FOR PERIOD (NET INCOME)** **TOTAL ASSETS**	27 682 000 GBP 653 000 GBP 11 266 000 GBP
PREVIOUS INFORMATION MANAGEMENT SYSTEM	Excel; iRely; Excel

4.2.1 Information Management System Architecture CS2 'Before'

Over the years, the company developed an information management system internally which was a network of linked Excel spreadsheets. There were three documents designated to the purchase and sales contract entry and hedges entry, over thirty documents that stored information on the inventory (thirty two stock sheets), shipment sheet and quality/sampling sheet were among others. The report to review company performance was prepared monthly to calculate the current value of stock and average margin as well as profit or loss. The report required two to three days to complete because it involves reconciliation of data from multiple sheets into a meaningful single report. Some other reports produced by the company include reports to international organisations that provide certification to the companies such as the Rainforest Alliance and Organic to show the amount of certified coffee traded. Additionally, as part of the information management system, the company managed its accounts using the Sage accounting package (see Fig 4.13).

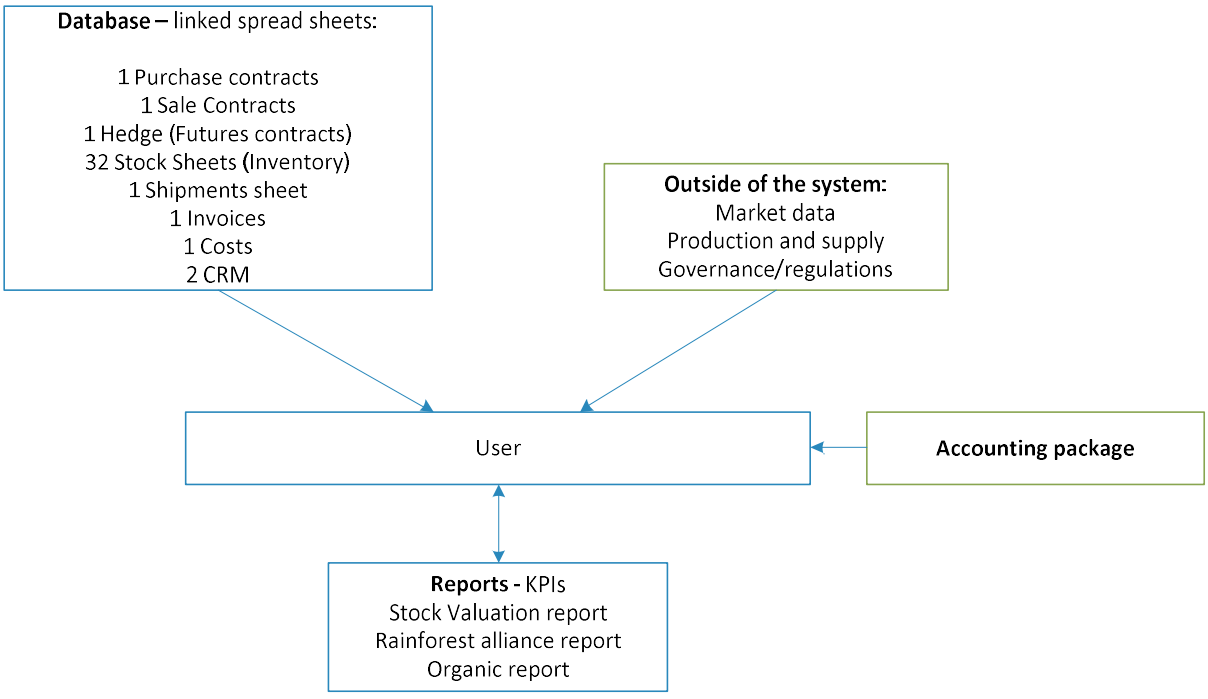

Figure 4.13 Information system architecture (CS2 'Before')

4.2.2 Company Operations CS2 'Before'

The position of the company in the coffee supply chain is presented on the diagram below (Fig. 4.14). The company is importing green coffee from farmers and producers at the origin focusing on specialty coffee grades supplied to coffee roasters for roasted ground coffee consumption.

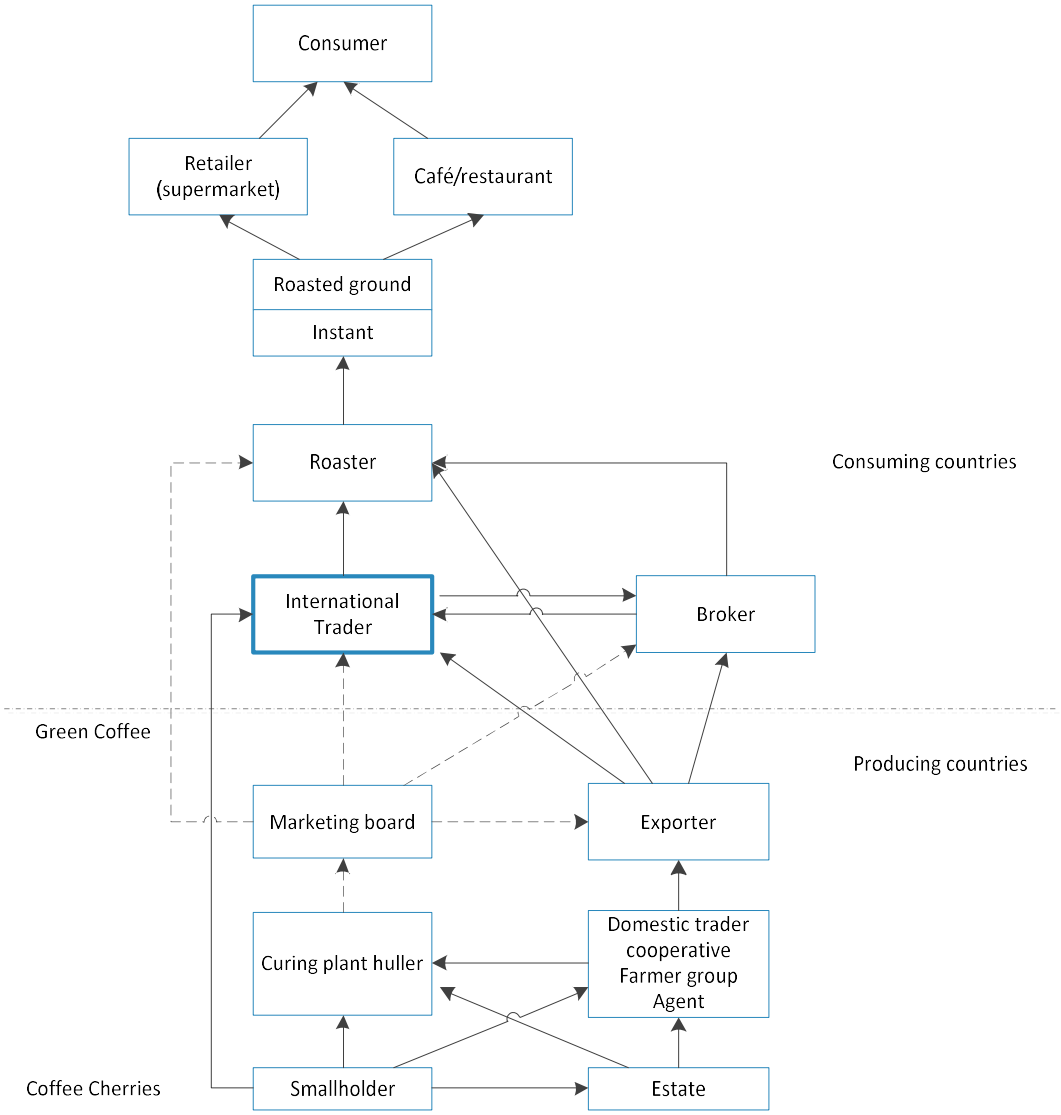

Figure 4.14 The coffee supply chain (adapted from Kaplinsky, 2004; Catturani et al., 2008)

Company customers include small-sized coffee shops and roasters across the UK and Europe as well as large size coffee companies with developed network of coffee shops. The company is trading a wide range of coffee grades from various origins and continuously reaching out to new producers and farms. Whilst many competing companies only buy premium grades of

coffee from farmers, trading intermediary are offering to buy the entire crop of coffee of high grades and lower grades to establishing long-term relationships with producers.

> "*We believe coffee is about people as much as it is about coffee. We've been building long-term relationships with a lot of the farmers, some over 25 years, it's about building sustainable business for them and for us and paying them a fair price*" (CS2I2).

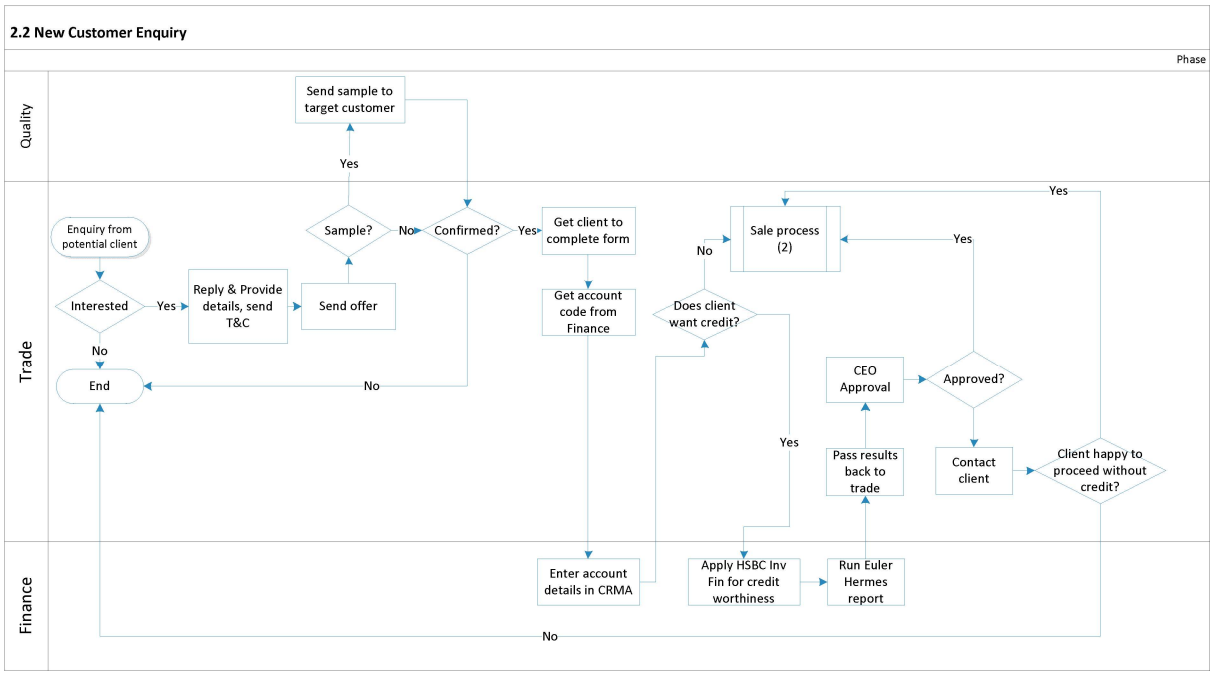

Figure 4.15 New customer enquiry (CS2 'Before')

The trader can be approached by the coffee producer and offered to sample coffee before any contractual agreements as well as the trader searching out for new coffee producers by travelling to distant farm locations.

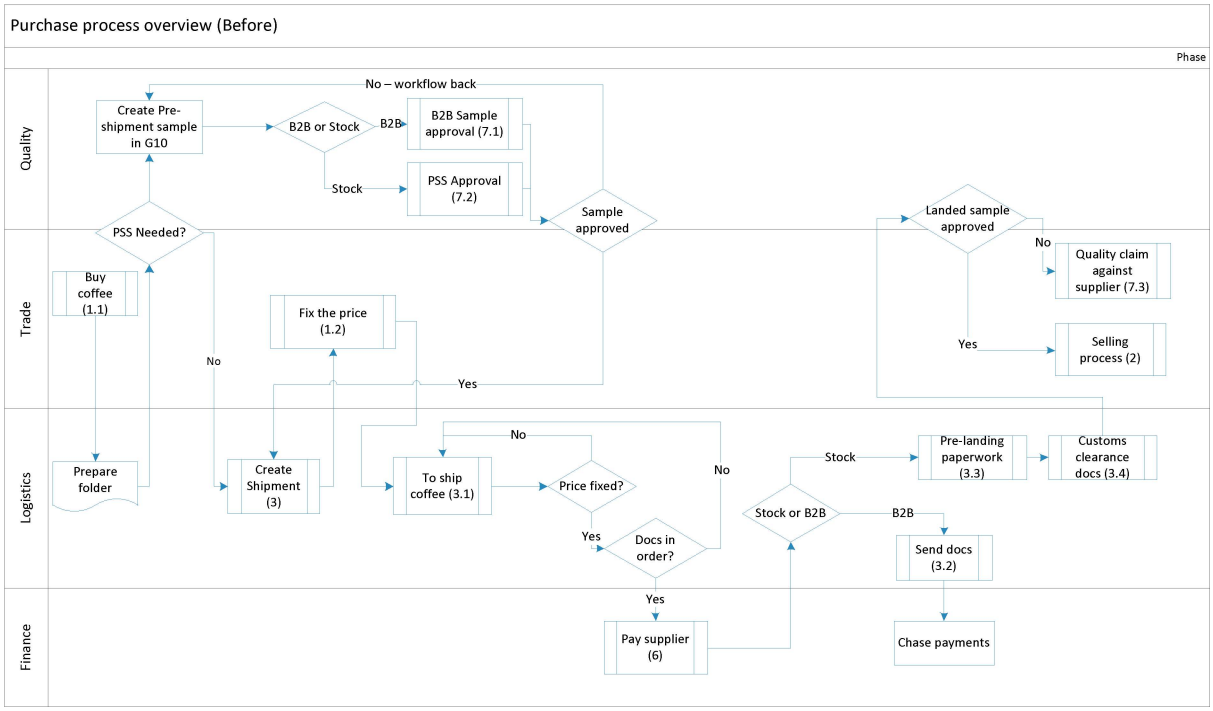

Figure 4.16 Purchase process overview (CS2 'Before')

When the price and contract terms (payment terms and Incoterms) are agreed, the coffee can be sent to stock and delivered to the warehouse or if the buyer(s) for this coffee are already known can be delivered "back-to-back" to the customer.

On the sale side, the coffee is sold to new clients that contact the company directly and distributed among long-term customers. To find new customers, the company does by so-called "traders push" - attending conferences and social media advertising to attract prospective customers. All the enquiries from prospective clients are checked on credit worthiness with the bank. Two main types of sales contracts include spot sales – sale of available stock, and forward sales – long-term contracts for future months. There are cases where the process of purchase and sales of coffee happens in reverse, with the coffee contract agreed with buyers before it has been bought. See additional process diagrams in Appendix 8-17.

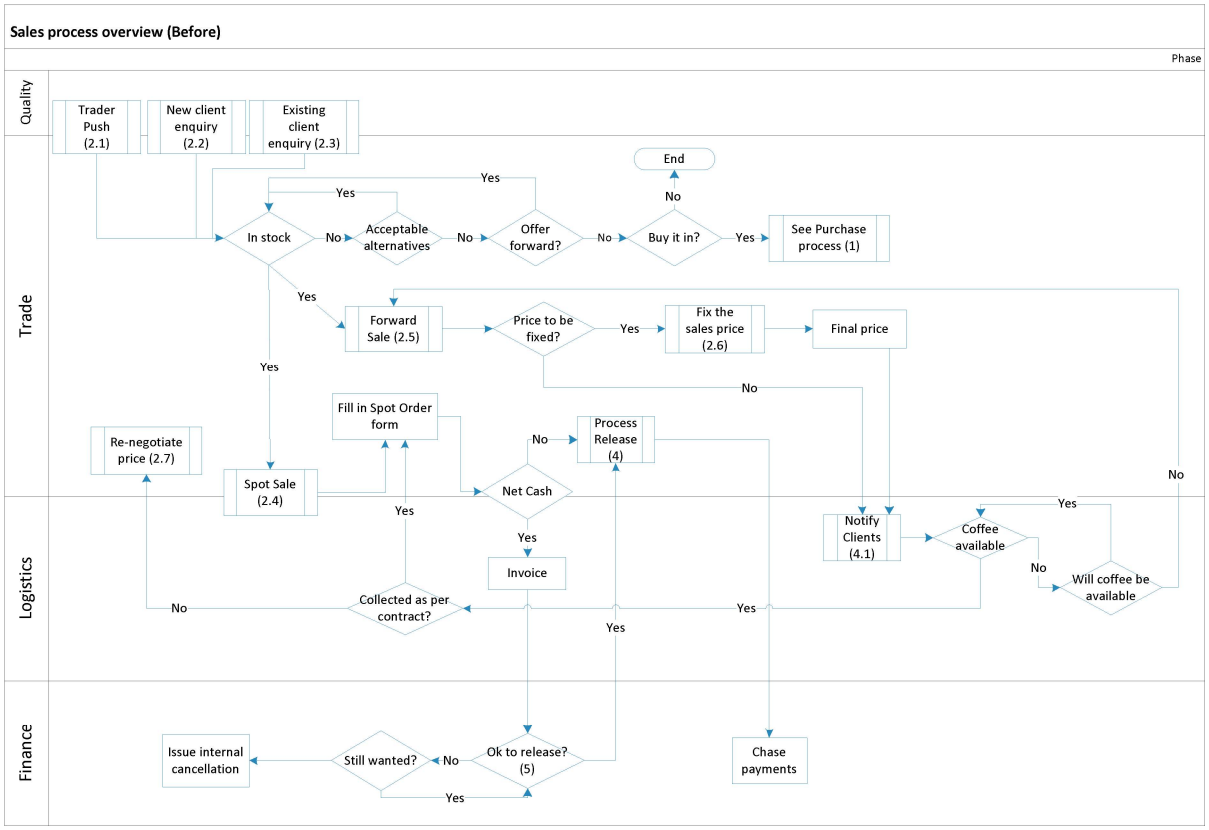

Figure 4.17 Sale process overview (CS2 'Before')

Intermediary trader also provides agency services:

> "*As commodity markets continue to liberalise and visibility of price, global production and demand improve, some customers want to do their own sourcing, however, they require help and knowledge of trading companies for customs clearance and effective deliveries of goods*" (CS2I1).

Coffee Pricing and Valuations

Coffee pricing is generally subject to usual market conditions like supply and demand, product quality and availability. The price also depends on judgement of the quality and flavour from the sample as well as on valuation strategies of the trader in current market conditions. The International Coffee Organisation (ICO http://www.ico.org/) is grouping comparable coffees and calculating average prices for those groups to establish comparative price market levels. The ICO also publish their predictions on availability and demand of coffee. These predictions generally refer to generic grades of coffee but do not cover specialty or gourmet coffees

where prices are calculated primarily using more sustainable pricing models "*designed to provide a solid, dependable and mutually agreed income for the producer"* (CS2I2).

In respect to pricing, coffee traders take on the risk of price changes between the times of coffee purchased to the time it's been sold. Secondly, by sourcing new grades of premium coffee, traders take on the risk of investment into potentially low demand grades.

There are two main contract price options – outright price or price fixed at the time of sale (also known as Fixed Price) or "price to be fixed" – price based on futures market price (also named On Call price). On call pricing secures 'differential' on or off the market price on the date of price fixation. Differential is agreed by buyer and seller and reflects valuation of the goods above or below standard coffee grades traded on the futures market.

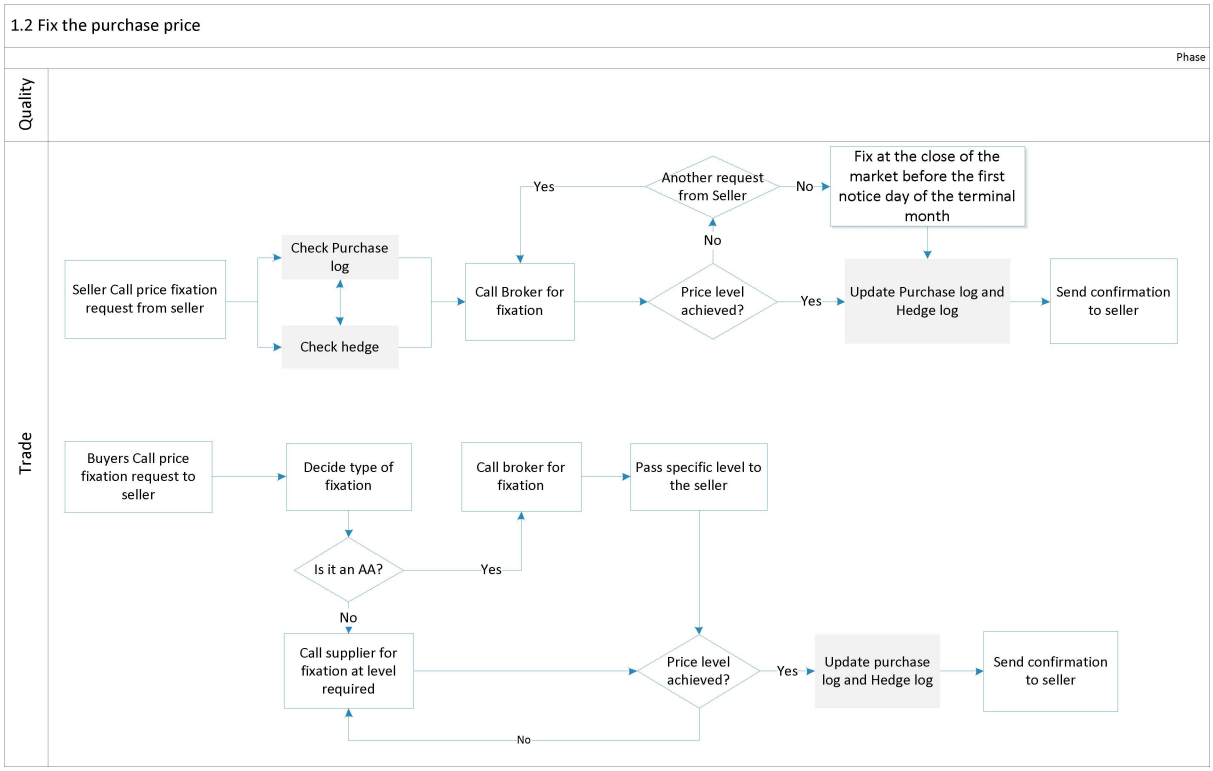

Figure 4.18 Purchase On-Call Price (CS2 'Before')

Allocations' Consolidation

The process of allocations of stock between purchased goods and sold contracts is driven by the risk management policy and relies on the information systems that company used. Every new sale contract (spot or forward) is matched with relevant coffee grades available from stock or forward purchase contract. This process helps to ensure that the company is not 'short selling' or miss coffee grades that they do not yet have and if they sell more than they bought this decision is made based on other allocations. But at the same time, the system was limiting traders from seeing available stock and un-allocated sales independently because the information was stored in three different spreadsheets. In this setting, the stock could be 'moved' (allocated and un-allocated) between multiple sales and purchase contracts every time a new sale contract was added until the date goods needed to be delivered. Excel databases cannot keep track of the changes made or the number of times goods were re-allocated as well as prone to human error.

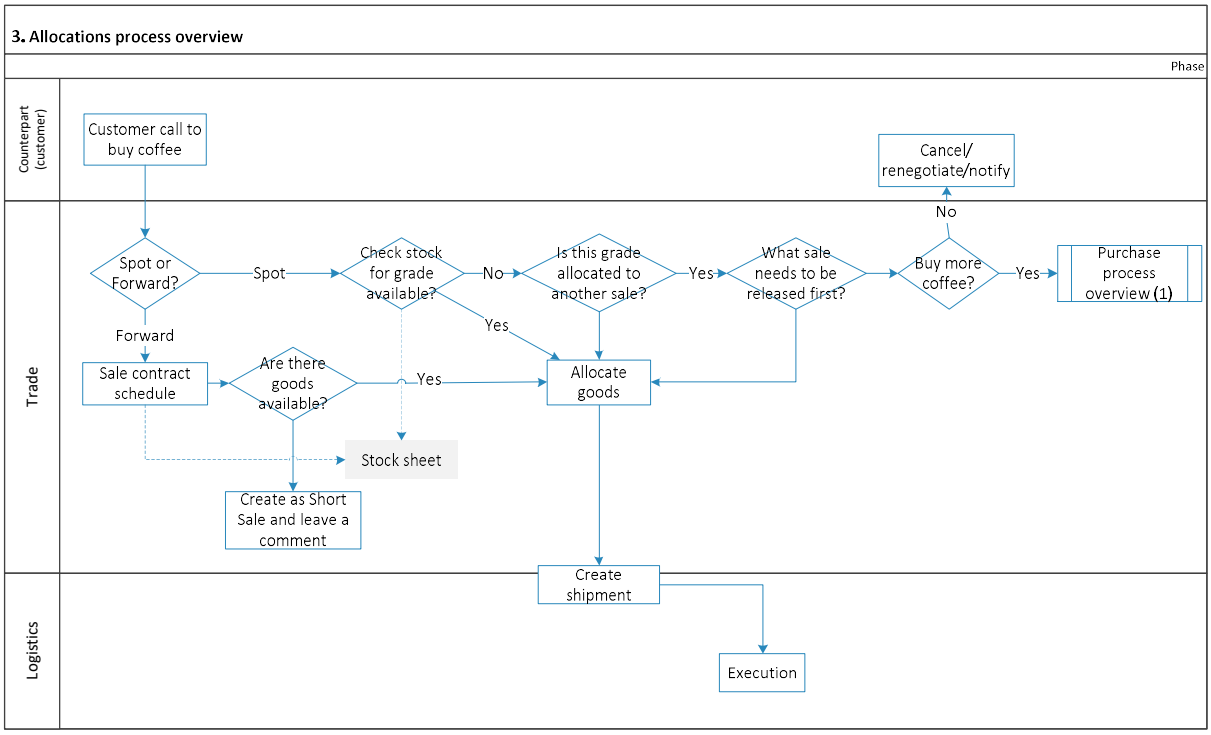

Figure 4.19 Allocation process overview (CS2 'Before')

> "*Not being able to see our stock position per origin/quality clearly and what will be our stock 'available' to sell is dangerous. Potentially we can over sell without noticing*" (CS2I4).

Shipping operations

The specificity of green coffee is that it is at its best quality when it lands in the consuming country, and the longer it is then stored the more it loses its quality by absorbing moisture from the atmosphere and fatty acids begin to oxidise and turn rancid. Buying companies try to avoid storing green coffee for an extended period of time, which requires them to order/buy coffee as soon as it's been harvested by means of forward contracts. The trader then should factor in the time between cherry ripening, time for drying, time it takes to deliver to ocean port, limited space on the ocean vessel, time taken on inspecting the coffee and finally delivering to the consumer to ensure regular on-time deliveries. The common stages of import shipments included in diagram in Fig 4.20.

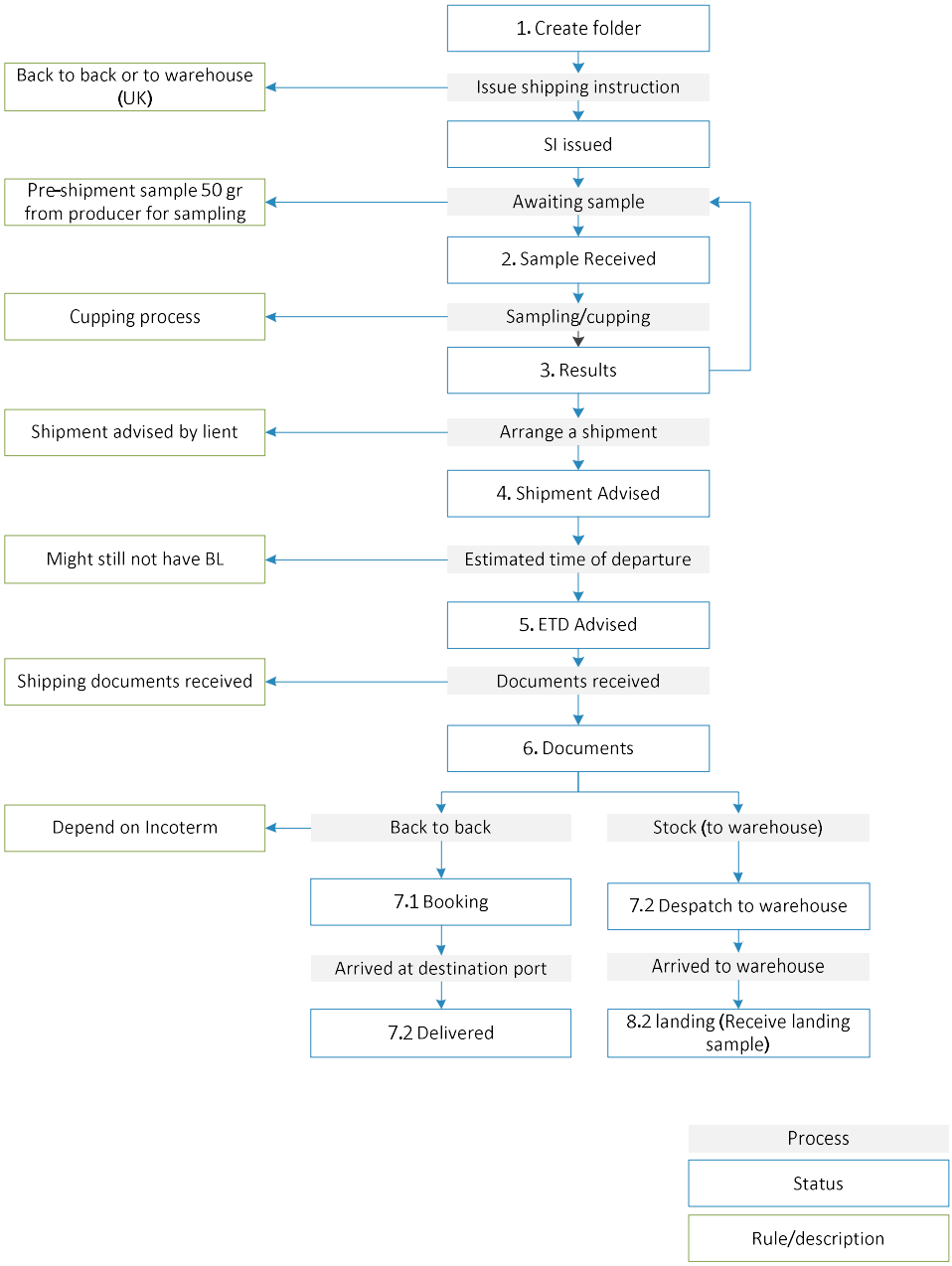

Figure 4.20 Import shipments (CS2 'Before')

Shipment paperwork and documentation are the key tasks of the shipment and logistics department. There are many documents required for customs clearance, landing into warehouse and deliveries from warehouse. For example, see process of goods release from the warehouse.

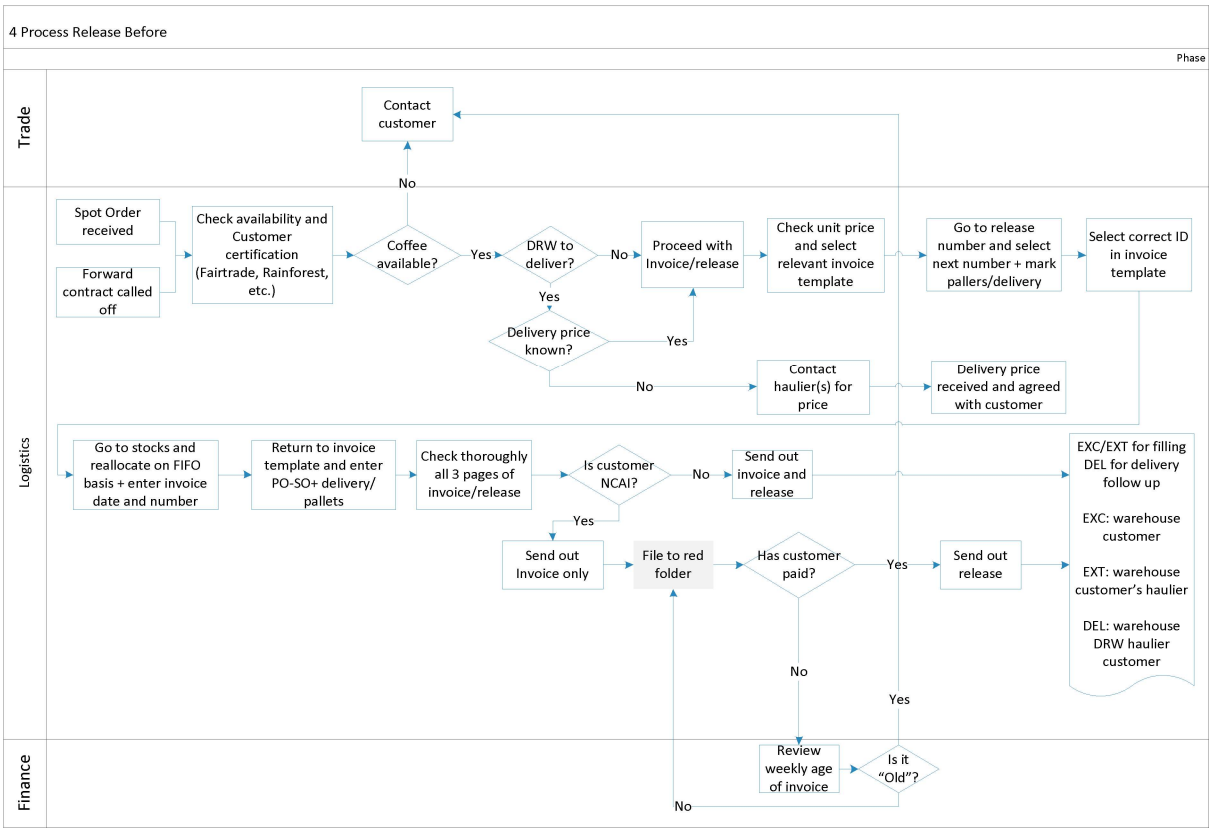

Figure 4.21 Process of goods release from Warehouse (CS2 'Before')

Furthermore, significant costs are required during the import and shipping process. The cost of inland shipments within the UK is particularly high and can be as much as ocean freight between Ethiopia and Tilbury. Moreover, the cost analysis preferably should drill down to bag per bag breakdown, because in the specialty coffee trade, coffee bags are the main unit of measure and require their own cost analysis and because every bag can be sold separately. So managing costs of shipment, storage and other charges is crucial for the business.

> "*To improve the way we calculate the cost of sale and understand all the costs, we need system that would be capable of calculating exactly which bags were in the warehouse between the 2 dates*" (CS2I9).

Coffee Sampling and Cupping

Coffee is repeatedly tested for quality and taste. This process is referred to as '*cupping* 'and usually takes place in a room specifically designed to facilitate the process and involves a group of tasters who sample coffee and agree on lot characteristics like flavour, acidity, body, etc.

> "*We've all been to origin and understand the coffee processing and understand how it operates, we see how the beans grow all the way through till they get to the UK. This gives us an opportunity to advise on blends and qualities of coffee*" (CS2I1).

There are two main samples that are sent to the trader for cupping – pre-shipment sample and landed sample. Pre-shipment sample is sent before shipment scheduled for delivery and sent by the producer two months in advance of shipment. If the sample is approved, the contract can be scheduled for shipment, but if the sample is not of sufficient quality it can be rejected and a new sample will be provided. If the sample is rejected 3 to 4 times, the contract is then cancelled.

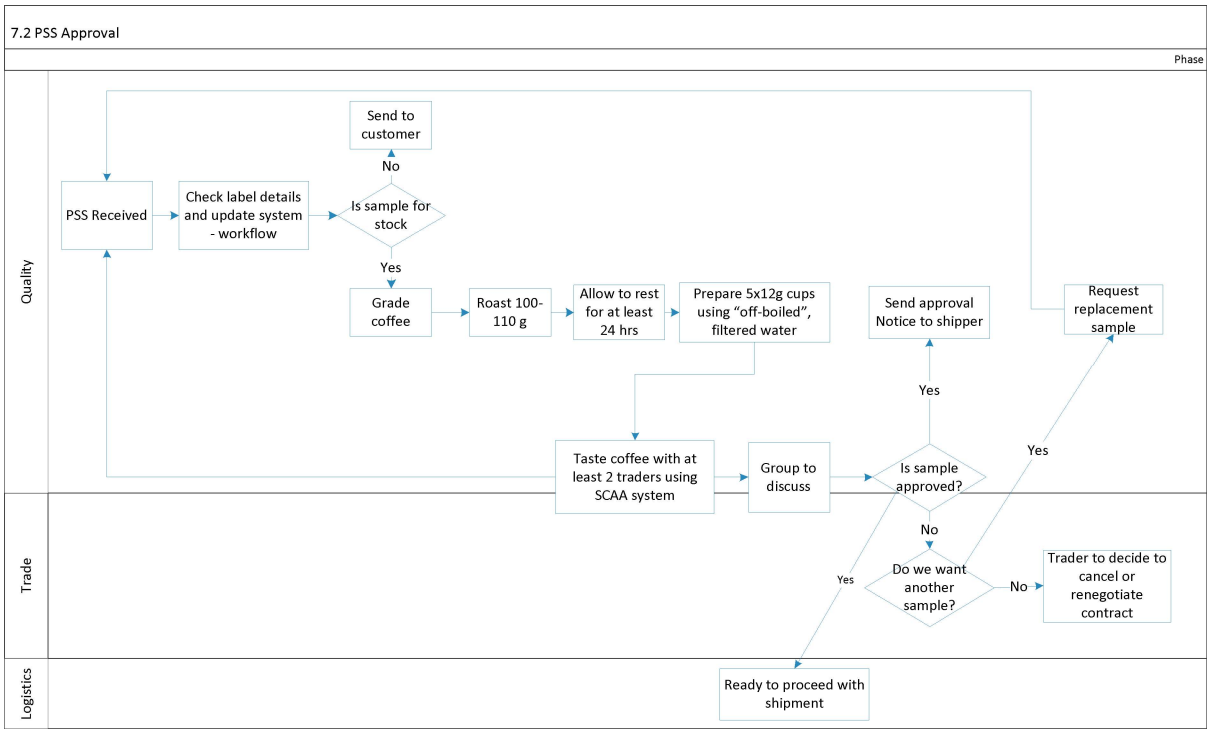

Figure 4.22 Pre-shipment sample approval (CS2 'Before')

The second sample is then sent from the warehouse where coffee was delivered (‘landed’) to ensure that delivered coffee is of agreed quality. The process of landed sample approval is shown below.

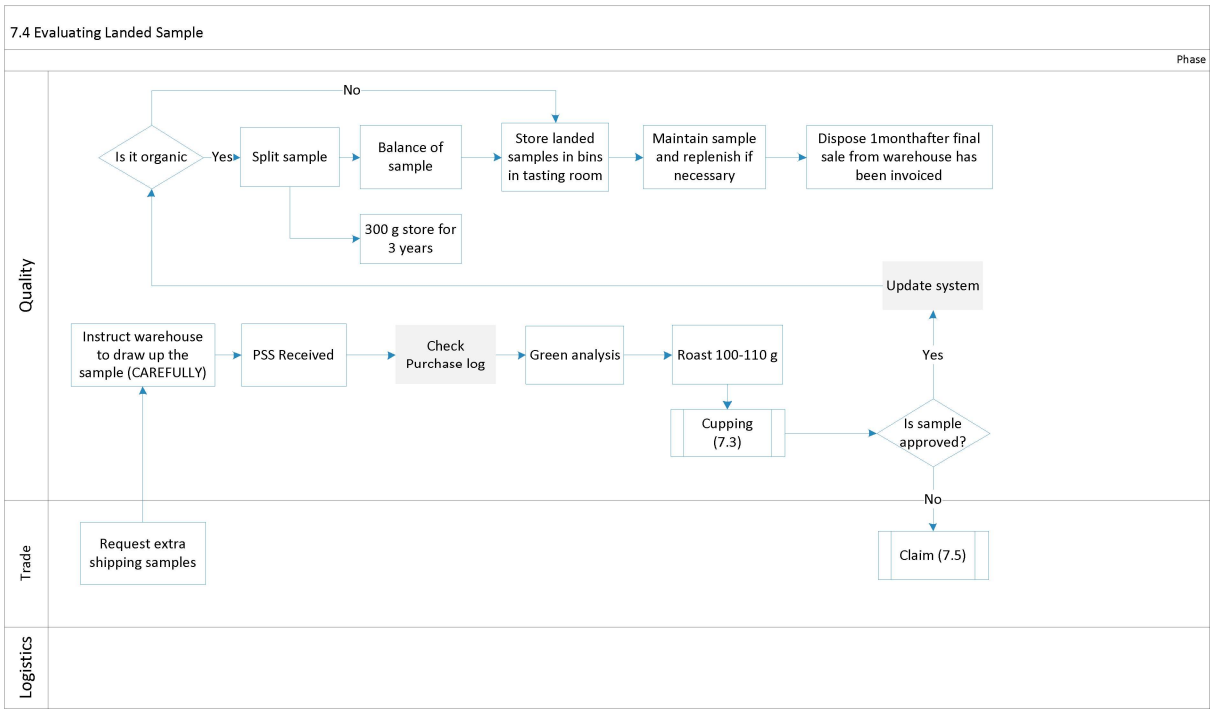

Figure 4.23 Evaluating Landed Sample (CS2 ‘Before’)

4.2.3 Supply Chain Governance CS2 ‘Before’

In the coffee supply chain, the trading company provides the link between the upstream coffee growers and downstream coffee roasters and ensures compliance with supply chain governance structures and regulations. The company is especially interested in certified coffees – Organic, Fair Trade and Rainforest alliance. The trading certified coffee requires additional reporting and compliance (see Fig. 4.24).

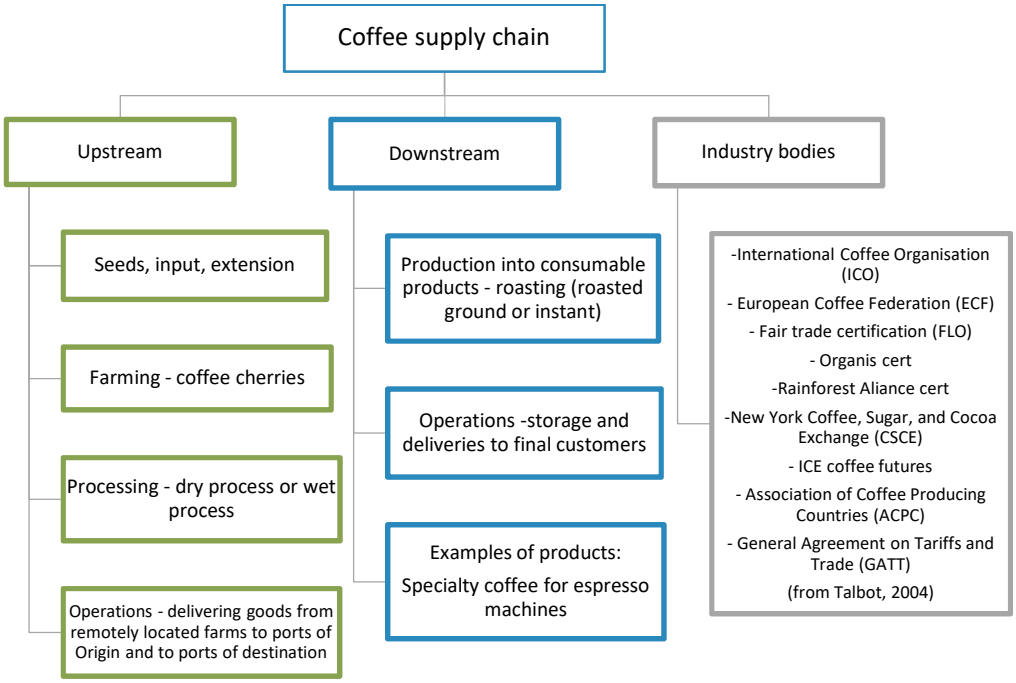

Figure 4.24 Coffee supply chain governance (CS2)

The Case Study Company is heavily involved in the Fairtrade initiative as well as being Organic and Rainforest Alliance certified. The coffee producers and customers are required to have the same certifications in order to brand their coffee as organic for example. However, the roasters have significant power in the supply chain and able to blend multiple grades and types of coffees. So the trader is making sure that the coffee documentation clearly states the certification applied and ability to trace any of coffees that they sell back to the origin.

Sustainability and social responsibility are highly important for the company and are reflected in efforts to link producers directly with roasters giving them the ability to develop their brand and representation on the market. The pricing for coffee agreed during negotiations with farmer with the aim to exceed the Fairtrade and Organic premiums.

> "*Typically the Ethiopian Coffee Exchange follows the NYC to some extent, but as a result of washing stations buying cherry at higher prices neither exporters/middlemen want to take a position. With an unstable market this causes an irregular coffee flow as well as diverting coffee to the local market and in some cases the black market. Ethiopia has developed a fairly stable and mature internal consumption demand which acts as the wing-man to the export business, taking up the slack when exports decline*" (CS3I1).

All the data regarding the origins, grades, certifications as well as customers and suppliers were kept in excel spreadsheets. This limits the opportunities for robust tracking and tracing of any changes and audits of data, errors or in-depth reporting.

4.2.4 Risk Management Policy and Procedures CS2 'Before'

There are many operational risks associated with the coffee shipping, storage and quality assurance. First of all, coffee is packaged by producers in bags or boxes that can be different size/weight depending on country of origin (e.g. 59 kg, 60 kg, 70 kg). The bags are then loaded to containers for shipment. The containers generally fit 275 70 kg bags or 320 60 kg bags and all the bags have to be calculated and weighed as well as ensuring consistency of quality across all bags checked. It is fairly common that the goods are 'short-shipped' or 'over-shipped' by only 1 or 2 bags, but require additional invoices for money returns and can affect the supply of goods to the buyers. More serious problems arise if in the landed sample tested the quality of delivered goods is not consistent with the contract the company has to raise quality claims to the insurer.

> "*Quality claims are lengthy and costly procedures; so we can accept the goods of lower grade, but never work with that supplier again*" (CS2I2).

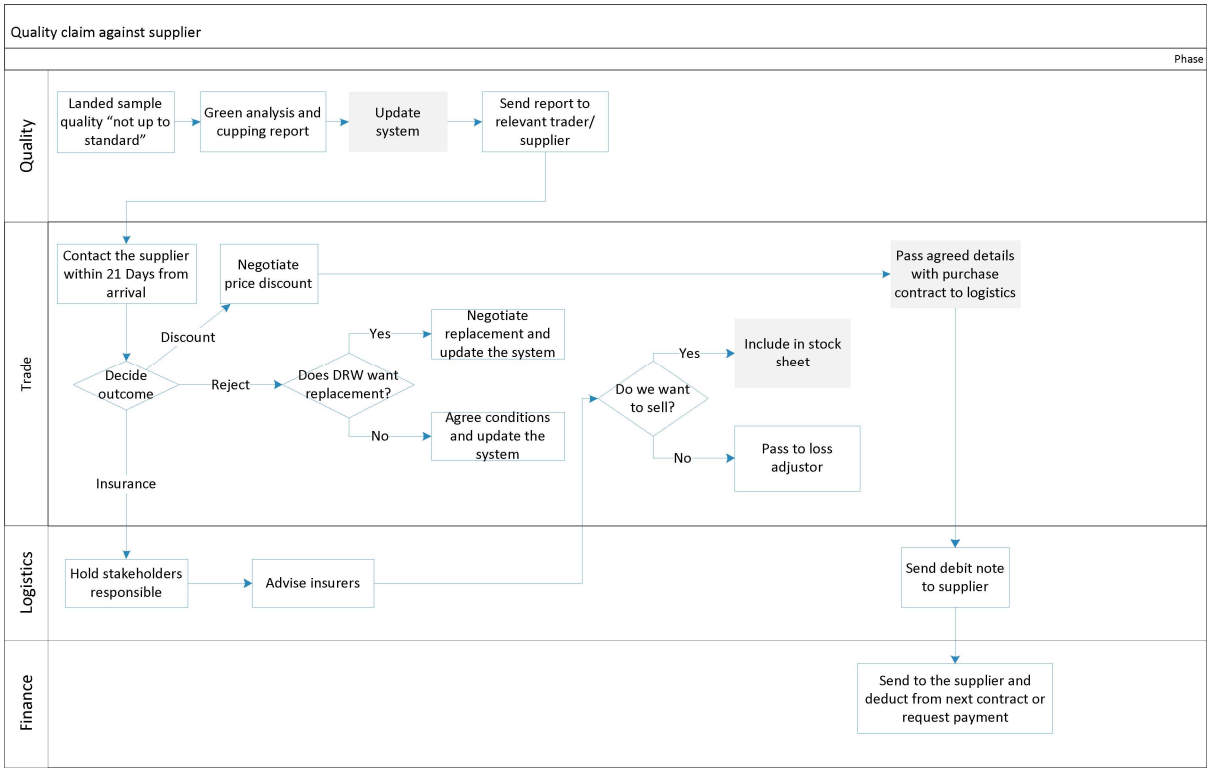

Figure 4.25 Quality Claim against supplier procedure (CS2 'Before')

Another operational concern is inventory management: the business model adopted by the company involves coffee bags stored in a warehouse before they are sold and then released to customers. The trader is using three main warehouses for customer convenience for pick-up of goods. The warehouses are provided with careful instructions for landing, handling and release of goods, but cases arise of damage or loss of goods that are required to be refunded by the warehouse. The management of goods entering warehouses, transferred between warehouses and released from warehouses have been difficult with the information management system based on Excel spreadsheets as well as keeping track of cost of storage per bag at any point in time.

4.2.5 Access to Finance and Company Performance CS2 'Before'

There are three main sources of financial risks for the trader: market price fluctuations, currency exchange rate fluctuations and customer credits and financing of goods (holding inventory). Arabica and Robusta coffees are traded on the futures exchange markets and can be used as a hedge against physical contracts. The contract sizes for physical contracts are not

the same as contract size traded on the futures market (standard ICE Arabica futures contract is 37500 lb) and physical contracts need to be hedged 'on basket'. Managing currency is as crucial as futures hedging. The company currency is British pound (GBP – book currency), futures markets currency is US Dollar and some of the customers are located in Europe and use the Euro. As for customer credits and financing operations, the company is complying with the procedure of creditworthiness checks of new customers through bank and strict customer payment terms defined in the contract. The company takes pride in the way it is providing value by providing it's services and the way it managed it's business.

> "*It's important that our customers, suppliers and our bank know that we are financially sound trading partner, they can trust us*" (CS2I9).

However, the improvements in the way the reporting is conducted, efficiencies and greater depth of detail of underlying costs was needed.

One of the biggest drivers for implementation of the information systems was the ability to review performance metrics and introduce new ways of assessing company performance. The company needed to define the existing and new performance indicators for the business. Two of the indicators used most are 'market level' and 'FX target'. These two targets were entered at the time of making a deal to reflect current market price and currency exchange rate taking into account the hedge transactions that have been done by the company previously. Some other performance indicators are average price margin and contacts exposure (number and quantity of un-hedged contracts). Logistics specific performance indicators should be developed after the project is complete.

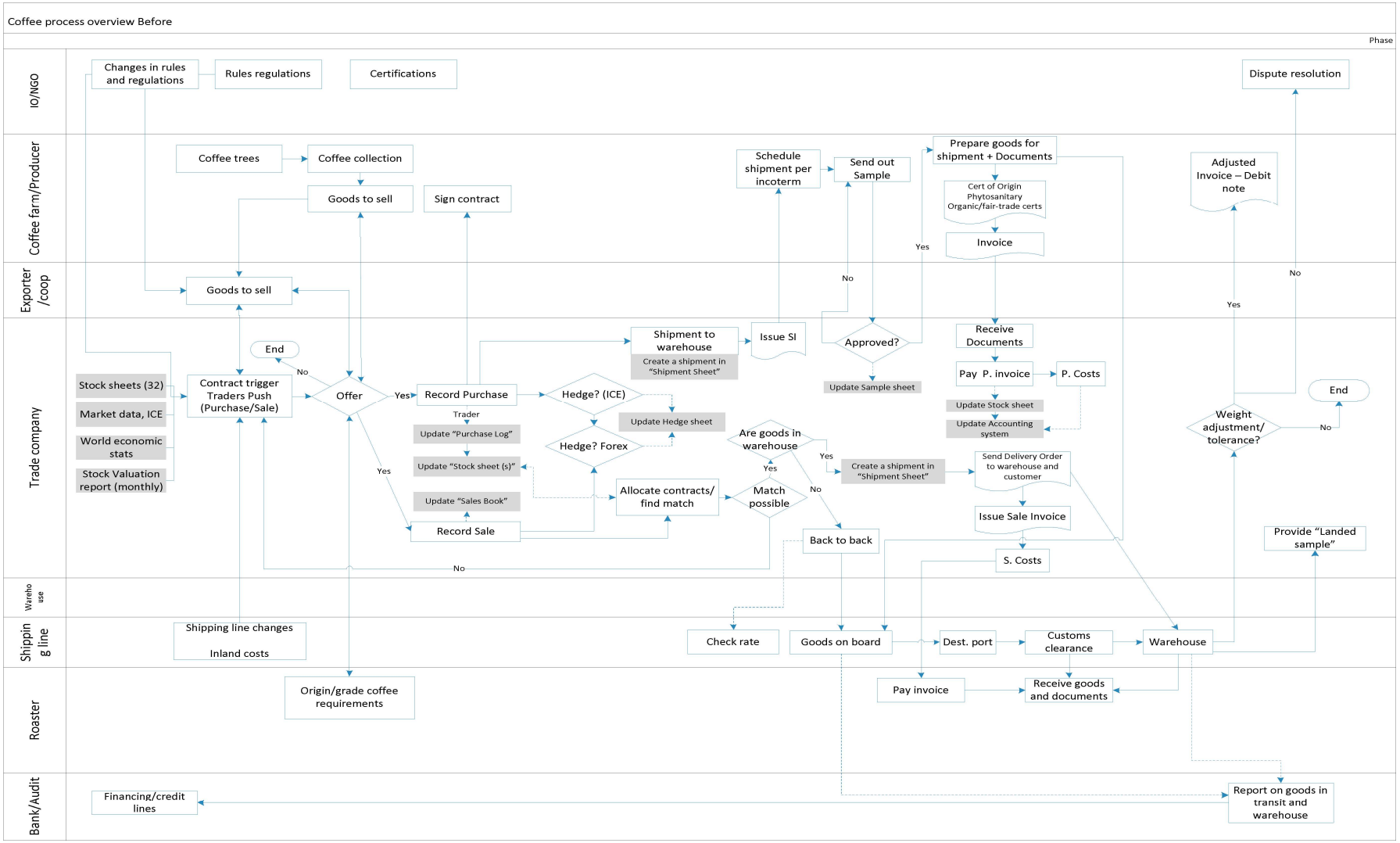

Figure 4.26 Coffee trading process overview (CS2 'Before)'

4.2.6 New DSS Architecture - CS2 'After'

The case study company was going through a re-design of its upstream information architecture based on the implementation of new decision support systems in three stages: vendor selection, implementation and post-implementation assessment. The first stage contained the vendor selection process, processes evaluation and gap analysis – missing functionality by means of feasibility study based on common trade and logistics scenarios, process mapping current business operations. The second stage started with gap development of missing functionality by selected vendor and testing, followed by training sessions and required customisations, documents print tailoring and workflows set up and parallel run. The third stage was the actual application and assessment of introduced change. Fig. 4.27 presents implementation plan produced for the project.

The strong growth in demand for high quality, fair trade and organic coffees led to an increase of operations in previous years and the use of Excel spreadsheets no longer provided the required controls over the data entry and integrity. Moreover, difficulties with extracting meaningful and trusty data from the spreadsheets as well as common user errors in the data became the first drivers to search for different software applications to manage trading and logistics operations. The first attempt to change management system failed to complete the implementation as the data imported could not be easily manipulated and operational procedures available did not satisfy operational requirements. It resulted in time and financial losses as well as user and management frustration as employees had to work overtime to complete data import. This situation allowed to reassess and better understand their own process requirements and functionality needs.

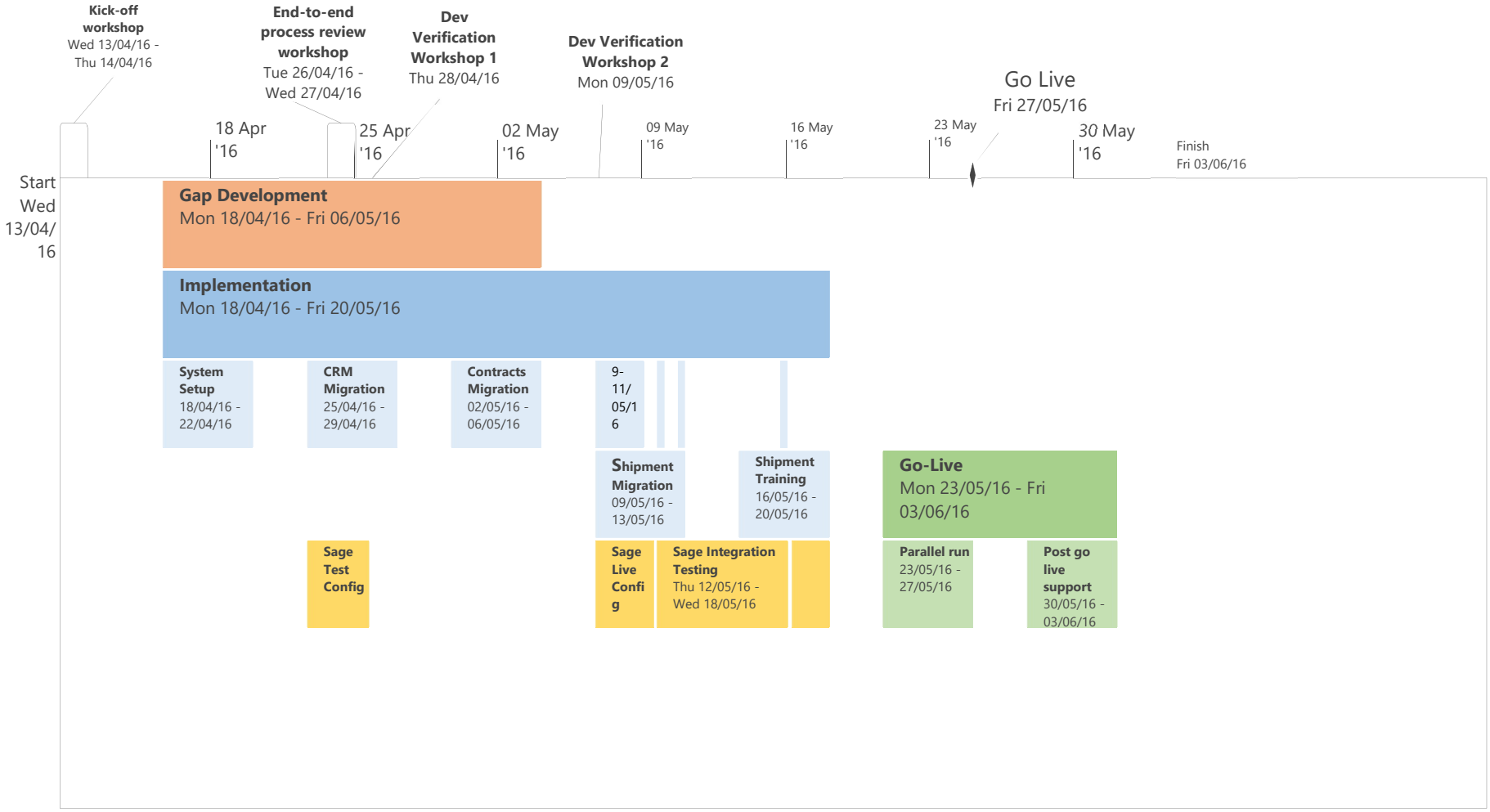

Figure 4.27 Implementation plan for Commodity Trading Management system (CS2)

It was targeted that a new software application will allow the streamlining and re-thinking of the processes and standardise existing data like customer accounts, grade names and descriptions. One of the main decisive factors was the ability to conduct and have good visibility over the hedge and price risk management procedures.

The project initiated with feasibility workshops involving different departments to obtain their input on issues such as pricing, hedge by baskets, traceability and reporting back on certified coffees (Fair Trade, Organic, Rainforest alliance). Case scenarios from every department were put together to test the software capabilities and a number of gaps were revealed. One of the significant changes required related to sales trading activities of the case study company – the sales contracts can be significantly smaller size lots of different grades of coffee. For example, N number of X bags of coffee A and N numbers of Y bags of coffee B. Moreover, due to small size sales, the hedging of financial risks is undertaken by use of hedge baskets. The three main gaps were defined as Spot Order sales; Hedging in basket and multi grade multi schedule trades.

The next stage was defining the implementation strategy and project planning. It was agreed that the gaps in functionality need to be completed before the user training or parallel run. Moreover, data migration required numerous reviews, manual updates, standardisation and mapping of terms that varied throughout the system generally due to human errors including grade names, customer names, locations and payment terms. It was decided to migrate 'open' contract (contracts that have not been sales invoiced), goods in transit (afloat) and in 'stock' (in warehouse).

The gaps in functionality were found around hedging – managing risks of price changes of physical goods by buying and selling futures contracts; selling small sized lots of goods from large purchases and selling different grades of coffee in one contract. The spec was agreed with the head trader and supported by the CEO. Weekly updates were scheduled with project managers to gather updates on development progress and identify any further requirements for functionality. The greatest challenge was to understand and document the processes and calculations made by traders to identify market price levels and purchase and sales prices for future contracts.

At a later stage in the project, another gap was identified in the 'quality' department and sampling processes. One of the core value-adding activities of the company is providing sampling of coffee and supporting it with company provided certification so that the clients are not required to go through the process of cupping. However, this requirement adds two steps into the shipment workflows and can extend the time taken for deliveries. It was revealed that two additional steps need to be added to the shipment workflows to accommodate the requirements.

The new DSS architecture graphically presented below.

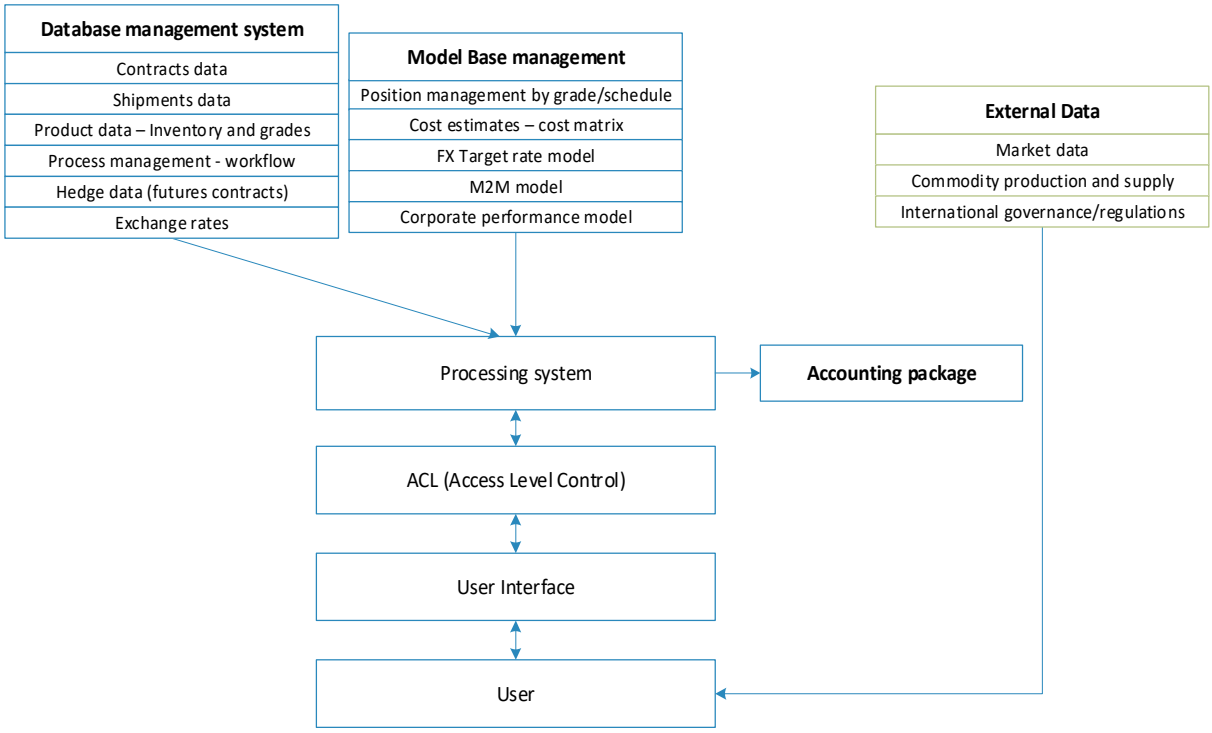

Figure 4.28 New Information management architecture (CS2 'After')

In this research project we could not oversee the final completion of the project, but the results that have been achieved during 6 months parallel run already show the changes introduced.

4.2.7 Company Operations CS2 'After'

The task of data migration during implementation project revealed large number of in-accurate or missed data about the contract details such as Incoterm country and places, comments on changes in price and shipping month, customer names, payment terms and grade descriptions in the spreadsheets. This created more chances for errors during shipment and delivery by logistics department. Moreover, some tasks were "borderline" between departments and could be executed by either department depending on availability. Due to the size of the trade, logistics and accounting staff it was easy enough to verbally discuss and resolve issues, however, the lack of a formal record of responsible or comments in the system would require long time to investigate events relevant to specific shipment. The information architecture allowed to review and establish processes and assign specific responsibility for task execution between departments as well as improve the quality of data in the system.

> "*I want to start to show how important clean data is in order to be able to use the widgets and reporting to their maximum*" (CS2I5).
>
> "*Our purchase shipments are updated at all times and 'workflow' done as soon as wed have copies of documents. If there are no shipment date in the system – that means we have not received any info. On the sales shipment – the workflow depends on when we raise the invoice and delivery order. This helps us track exactly where the shipment is at*" (CS2I8).

The efficiency was greatly improved for the logistics department. The factors that contributed to the improvement included pre-set reports, automated document generation as well as more accurate data across the system and introduction of workflows across the system. The accounting team has also gained efficiency in processing invoices and invoices upload into the accounting package, as well as time spent on accounting month close and valuation reports. One of the most important improvements was the controls over customers and suppliers database, database of special customer instructions and payment terms definitions enabled by the new system. On the contrary, trade department reported increase of time required for entry and administration of the contracts and allocations because they were responsible for more precise data entry. The reviewed company processes now required higher involvement of the trading department into logistics operations. In order for logistics staff to know the requirements for the shipment, the trader needs to define what purchased coffee will be sold

in given contract which means make an allocation, as well as identify what purchased contracts will be delivered in one shipment.

> "*We expected the system to be used by the traders directly and wouldn't require an admin person*" (CS2I2).

The change was recorded regarding interactions between the Quality department and other departments. The main interaction between 'Quality' and traders happen when the sample was received and ready for cupping or in case the sample was rejected and the price needs to be re-negotiated or quality claims have to take place. Logistics department and 'Quality' mainly interact when the pre-shipment sample is subject for approval before the coffee can be shipped. Both departments been working in parallel to check what contracts are scheduled for shipment in two months' time and check what shipping instructions logistics need to issue and what samples 'Quality' need to request. The new process allowed them to set up rules, steps and deadlines for better visibility over actions taken and improve internal cooperation.

> "*We wanted to stop single points of contact and move to a team mentality when working with the system, encourage taking ownership for the tasks completed in the system*" (CS2I5).

Inventory management benefited from accurate and reporting and bag per bag cost analysis capabilities. Moreover, the new system allowed to trace "slow" moving grades of coffee and find any leftover bags in stock as well make more reliable analysis of warehouse's performance as a service supplier based on number of bags lost or damaged.

4.2.8 Supply Chain Governance CS2 'After'

The international certification bodies such as Organic, Fair Trade and Rainforest Alliance are the most significant bodies to support sustainability efforts in the supply chain. The Case Study Company is certified by those bodies and provides regular reports for coffees bought and sold. The trader has to keep a good record of customers and suppliers on certifications that they have because a customer that has not been certified by a Fair Trade organisation can not advertise the coffee as Fair Trade but will be required to pay appropriate premiums for Fair trade coffees. Accurate and up-to- date records in the new system should allow the

company to make reporting more effective and ensure traceability of every bag of coffee sold by the organisation.

The big change involved the numerous controls introduced into company processes. Standardisation of grade names and attributes and other contractual terms. Data allowed for further analysis and better understanding of all the costs involved into the trade cycle per every bag of coffee. The changes should lead to stronger transactional governance by the intermediary.

4.2.9 Risk Management Policy and Procedures CS2 'After'

The nature of the business required for hedging of small quantities of coffees that are being sold for the future months. The difficulty arises when managing, analysing and auditing multiple small contracts hedged 'on basket'. Secondly, the company is using three different currencies for trade operations – US Dollars, Euro and British Pound Sterling. The management and visibility of currency exchange rates and exposure was proven difficult in previous systems used. Overall, the company was driven by the need for better data, information, process management and visibility in order to grow the business in terms of operational volume and profit. The needs to "hedge on basket" due to small quantity contract was specifically designed and developed in the system. The new system greatly improved visibility of the company risk exposure – contracts that have been hedged against futures market and contracts that have not been hedged as well as over-hedged contracts. The executive board have easier access to the hedge information contract per contract. Another aspect of company exposure is currency exchange rate hedge. The currency hedge is done at the time of making a deal even though the contract is not due till next year for example. The traders enter the 'target FX rate' at the time of entering all contracts, which then calculated weighted average of those rates across open contract to give the trader an indication of the exchange rate they need to get to buy/sell currency to ensure that they are not losing money on exchange rate fluctuations.

Another change in risk management processes concerned allocations process. The company was required to allocate and re-allocate, split and recombine the lots for every new sale

contract. The task would not necessary take a long time in Excel, but highly error prone and lacking history or comments why particular goods were reallocated or how many times the goods were moved between customers. The procedure was established due to lack of possibility to overview the company position in one place and to ensure that nothing has been 'short sold'. The new system provides an overall view of company stock and future contract allowing them to short sell with minimised risk of missing any contracts out.

Previously, company exposure and hedge decisions heavily relied on the traders' knowledge and experience and trust between executive board and traders.

4.2.10 Access to Finance and Company Performance CS2 'After'

Customer credits and different payment terms with suppliers are customers is one of value adding activities by the intermediary company to the supply chain. The difficulty the company had was easy access and availability of data. The time required to produce manual reports and provide analysis that would lead to company decisions was difficult. The company and partners performance data is more accurate and readily available at any point in time. Moreover, the procedure of company monthly and yearly accounts closure will become more automated are require less resources. The targeted company growth should be enabled by negotiate larger credit lines with banks and conduct more business in the supply chain.

> "*Sterling value of our stock can be easily accessed from one of the grids at any point in time, the system devalues all of the stock at the current exchange rate if the contract was made in Euro or Dollars. Storing historic values for our reporting is also helpful*" (CS2I10).

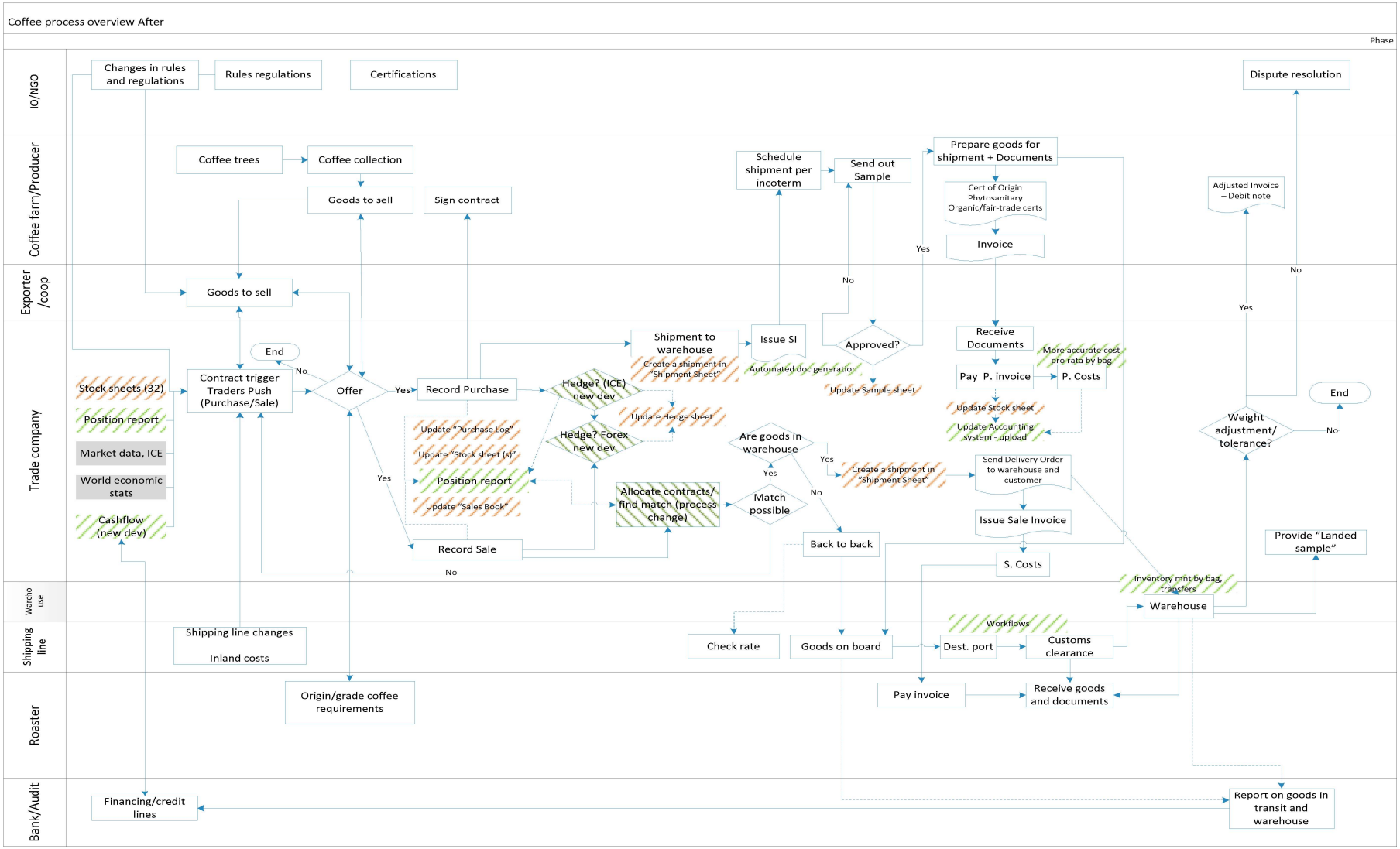

Figure 4.29 Coffee trading process changes (CS2 'After)'

Table 4.5 summarises the Case Study 2 funding from the analysis of data from the interviews, observations and process maps completed.

Table 4.5 Case Study 2 Findings

	'BEFORE'	**'AFTER'**
GOVERNANCE	Error prone data by customers and suppliers Time consuming reporting	1. Transactional governance – establishing workflows 2. Contractual governance – improved controls over data quality and company performance 3. Supply chain governance - Traceability and transaction history 4. Supply chain governance - Easier record and report back on certified coffee traded
RISK MANAGEMENT	Trader's personal judgement and reporting on company hedge position and exposure	1. Hedge record for physical contract 2. Visibility over company long or short position 3. Single Position sheet and company exposure 4. Stock valuation accuracy
TRADE FINANCE (ACCESS TO FINANCE)	Time consuming reporting (Stock Valuation report)	1. Availability of data on stock value and exchange conversions 2. Historic data about exchange rates used 3. Automated reports on performance for bank
OPERATIONAL EFFICIENCY	Lack of easy traceable performance measure Errors/omissions in data Manual documents and reports updates	1. Inventory management (stock, cost and demand analysis) 2. Automating generation of supporting documents 3. Company processes review

4.3 Case Study 3. Cotton Case Study Overview

The company is a medium-sized, cotton-trading company, a subsidiary of a large agricultural trading and producing company. It is one of the world's largest and oldest businesses involved in cotton trade. The business includes a network of trading offices, cotton gins and warehouses and is involved in cotton production as well as the main activities associated with distribution. Amongst the company's stated targets are the delivery of customer quality requirements, support for smallholder farmers and supply chain risk management. The business has been transforming over last decade to adjust to the changing world economic conditions.

> "*The cotton business has seen many changes over time but in the last ten years we have witnessed our business moved in a major way to electronic trading which in turn led to the collapse of some very major merchants (one merchant, with over 150 years trading history, was reported to have lost over US$ 200 million in one day and caused its bankruptcy)*" (CS3I1).

Table 4.6 Case Study 3 Overview

CATEGORY	COMPANY DETAILS
LOCATION	UK
MAIN ACTIVITIES	Sourcing, trading, storage and deliveries of cotton. Growing of Fibre crops, warehousing.
NATURE OF BUSINESS (SIC)	46760 - Wholesale of other intermediate products 01160 - Growing of fibre crops
COMMODITIES	Cotton
ESTABLISHED	1976 2005 Ownership: Private limited
NUMBER OF EMPLOYEES	29 (from 2011)
OP. REVENUE (TURNOVER) **PNL FOR PERIOD (NET INCOME)** **TOTAL ASSETS**	281 686 000 GBP -802 000 GBP 81 847 000 GBP
PREVIOUS INFORMATION MANAGEMENT SYSTEM	Excel

4.3.1 Information Management Architecture CS3 'Before'

The information management systems consisted of a network of shared and interlinked Excel spreadsheets. Additionally, staff created spreadsheets for their personal use with the layout that they found most useful for their personal purposes and reporting. The company found that about 2,000 different spreadsheets were in use by different departments and people across the organisation. However, such information management systems were error prone and unsecure because documents could be sent via emails or portable hard drives.

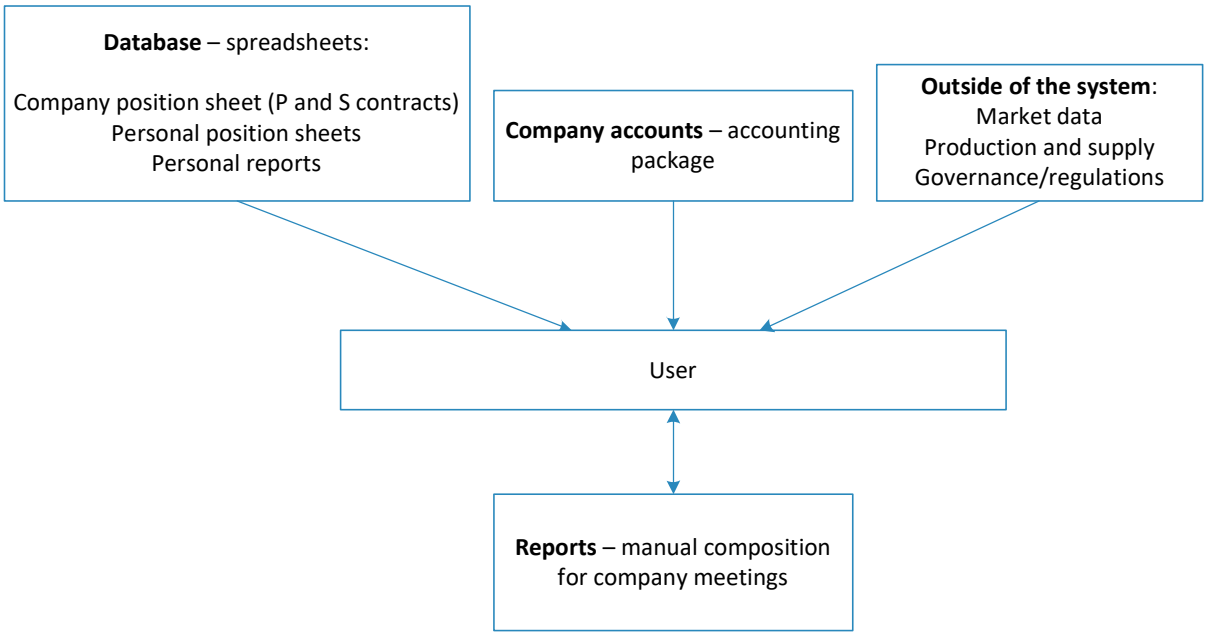

Figure 4.30 Information management architecture (CS3 'Before')

The details of the use of the system presented in following subsections.

4.3.2 Company Operations CS3 'Before'

Cotton supply chains have been discussed in detail in Chapter Two. The case study company is referred to as an international trader or often appears as merchant in literature. The main supply chain partners include farms and cooperatives, gins in case the farmer is using separate ginning facilities, spinning mills on the purchase side, brokers, shipping companies, warehouses, and inspection companies as service providers.

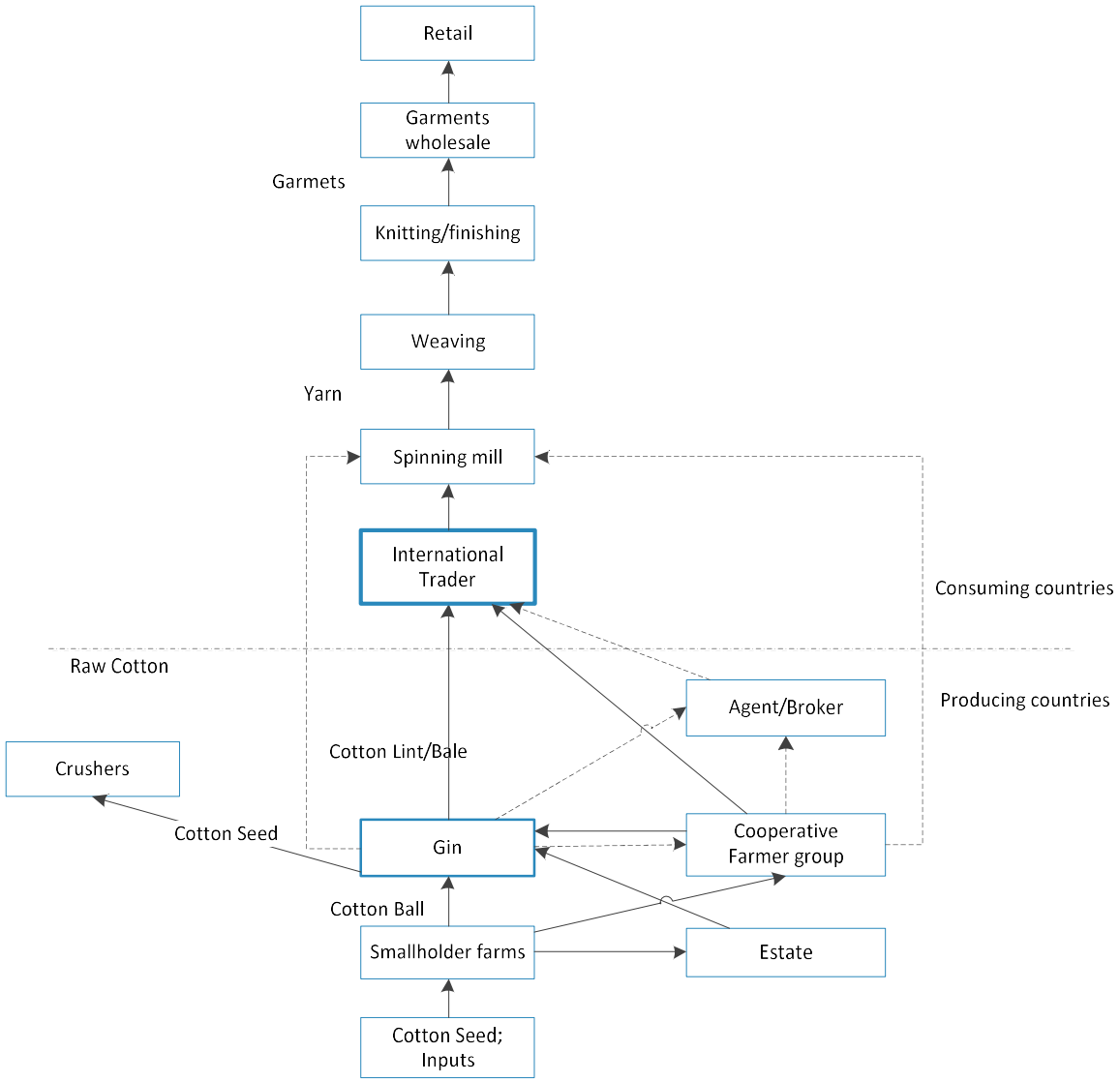

Figure 4.31 Company position in Cotton SC (CS3)

The cotton trader is using a number of data sources to make decisions for purchases or sales of cotton. Market data includes the Cotlook A index and daily ICE cotton futures prices. Secondly, they monitor the world economic situation as well as production, consumption and import/export stats for the previous, current and forecasted future crops worldwide. The local agents provide another source of information about local market conditions from the farm or fabric mills and participate in negotiations on the terms of the contract such as price, payment terms, delivery terms and grades. The changes in shipping and logistics, such as costs or routes, can also impact the decisions made by the trader. Finally, and probably the most significant information for the trader, are the position report and company cash flow. The

information allows them to see what the current contractual obligations per month are and what financial capacities they can use.

Once the contract terms have been agreed, the contract is created and entered into the company position sheet(s). The cotton purchased on one day is rarely sold on the same day. The trader needs to ensure the differences in price and successful hedging to guarantee the margin that covers operational costs and is profitable for the company. The next step in the process requires a decision to hedge the physical contract against futures contracts on the exchange market or keep the contract 'un-hedged' and monitor as part of company contracts price risk exposure. Hedging is also required if the contract currency is different to the company operational currency. For example, the contract is made in EUROs, but the commodity tradable currency is US Dollars, so the currency exchange rate is hedged too by buying or selling currency at the most favourable rate.

All the transactions and information about the contract terms are updated to the position report by the 'position manager'. However, as was mentioned earlier, the traders could maintain their own separate spreadsheets that they used to manage their own position. The task of reporting and combining data from different reports is a time consuming task and quickly becomes outdated.

Pricing/Valuations

The pricing of cotton depends on the quality and grades of cotton crops. The pricing is relative to the costs and risks involved in the transaction. The valuation process is required to establish the current value of goods that have been purchased and part of the inventory, as well as the value of the future transactions or contracts that have been agreed, but not yet shipped. The trader requires an objective overview of the operations to make a reasonable judgement. This task is also time consuming and can only be done once a month whilst market prices of cotton continuously fluctuate on the market.

Allocations

The process of allocating the cotton that will be sold/delivered to the buyer is conducted by the position manager or trade assistant. The trader is normally the one who makes that decision but the process is completed by another staff member as an administrative task. If the match is not available and the contract is coming to its shipping month or the company's position is 'long', inventory is sent for storage to the warehouse(s).

Shipping Operations

The company developed a wide network of offices that deal with purchases, sales and shipments of goods as well as ginning and warehousing facilities. There are four warehouses operated by the company, and a number of third-party warehouses used to ensure more reliable and convenient shipments for customers. The company provides the delivery of goods and quality assurance and considers it as a competitive advantage to provide flexible delivery options for grade and volume requirements. Shipment documentation is crucial for on time efficient deliveries and timely payments.

Quality Assurance

As previously described, cotton grading and quality names vary across the producing countries, but efforts have been made to introduce a centralised database of a bale-by-bale cotton laboratory machine testing called HVI (high volume instrument lab testing). At the same time, some countries are still using manual cotton grading. To ensure that the cotton quality contracted complies with the quality of the goods shipped, the trading company arranges for goods inspections at ports. The cotton inspections are conducted by designated Inspection services companies, which check the weights, quality and security of containers – numbers and seals. Cotton weight is checked too because it can fluctuate due to moisture content changes. The cotton is inspected on average twice – before shipment (Net Shipped weight) and on arrival (Net landed weight).

> "*Operational - another major change is that in the past we have trusted customers with whom we have had very long relationships to honour contractual obligations and been willing to put cotton on the water even before we have a workable letter of credit thereby covering us for the*

cost of the cotton we are shipping. Due to reasons partly given above, no customer is now guaranteed to survive possible market fallout and we therefore will not, under any circumstances, ship cotton without an absolute irrevocable letter of credit and therefore minimising any risk of losing the value of such cotton to the absolute minimum." (CS3I1).

4.3.3 Supply Chain Governance CS3 'Before'

Cotton supply chains are highly decentralised and complex due to the number of countries and organisations involved in the farming, shipping and production of cotton. The case study company is sourcing cotton from many countries across the world and is required to comply with the specific rules and regulations of those countries as well as industry specific international organisations like ICA, ACSA and ICAC.

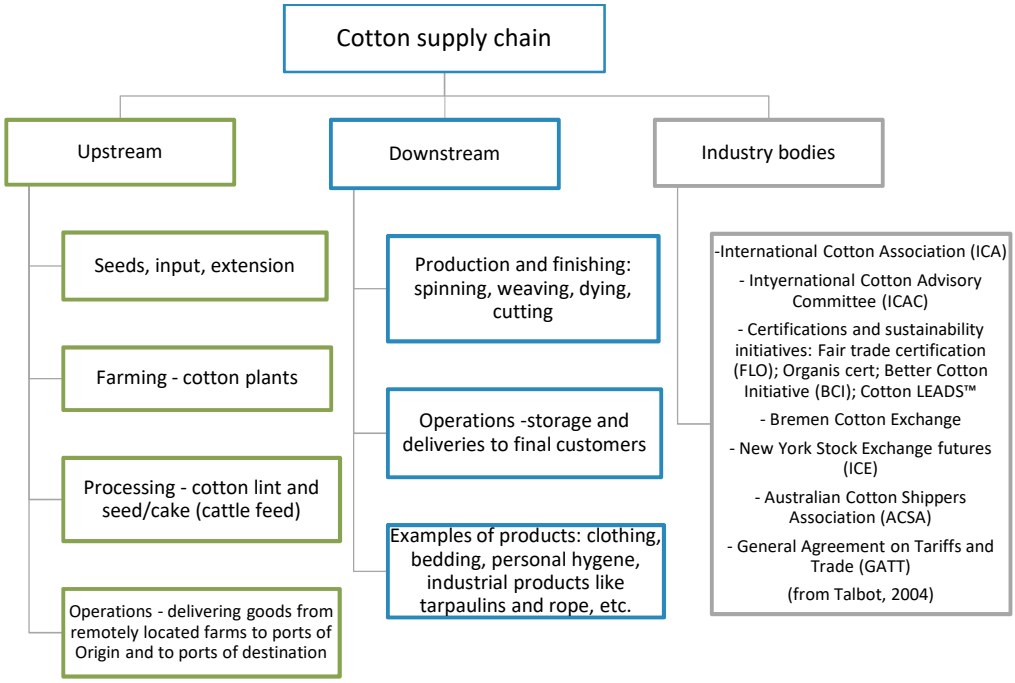

Figure 4.32 Cotton Supply Chain Governance

Cotton is grown in 70 countries around the world and standardisation of cotton grading is not always possible. The seed variety and certain weather conditions can affect the quality of cotton every year. Standardisation for the grading of cotton is also complicated by the number of attributes of cotton such trash, length of fibre, etc., so countries are still using different names for cotton grades. The ways that cotton is planted and collected can make a

difference too. Some more developed countries such as Australia, US and North West China are using specialised machinery that allows them quicker and more efficient crop processing on an industrial scale. The Case Study Company offers its expertise of the grading systems and knowledge of the countries' local conditions to add value to the customers and supply chain.

Requirements sustainability and ethical cotton practices shape operations and strategic decisions of cotton trading companies. The access to market information and company presence in producing regions makes it possible to collate significant data for informed decision making for the company and their partners. In addition, understanding global governance and finance structures provides the capability to secure funding solutions to customers.

Some of the collaborative initiatives with supply chain partners include agronomic expertise and training, "operational efficiency, risk management products, or other financial solutions" as well as marketing the grower's goods. Sustainability is claimed to be an important aspect of company business; and promoted through the improvement of farming working practices, work with local communities and helping growers improve their performance.

4.3.4 Risk Management Policy and Procedures CS3 'Before'

As with other tradable commodities, the price of cotton is highly volatile on the futures market. Most of the trades are hedged against the futures contracts or options. Position and cash flow management are crucial for business because the company has to always budget for margin payments if the futures price changes. It is crucial for the business to complete the business cycle in the quickest possible time scale. This means reduced time between the payment for goods and receipt of finances for the goods sold.

The company recognises Risk Management as the key business capability. Risk management for price fluctuations, operational disruptions, costs management and trade finance support are widely advertised as value added to the supply chain.

> "*We (cotton trading) moved from a futures market based in the New York "pit" where traders controlled the daily volume and volatility of the market to full electronic trading with no limits to volume or volatility. One of the biggest risks we face today is that a market with no limit effectively*

means a daily movement which could cause significant volatility and in turn significant losses if we are on the wrong side of the market" (CS3I1).

Trading operations commonly rely on the trader's intuition as well as established relationships with their partners. The old system of spreadsheets and different reports could not provide the reliable presentation of the judgement behind decisions made and actions undertaken. The world economic crisis of 2008 showed the gaps in current risk management practices and requirements for improvements. The core of the world economic crisis was a loss of credit by many supply chain participants and companies no longer being able to perform according to the agreements, which led to multiple defaults on contracts.

4.3.5 Access to Finance and Company Performance CS3 'Before'

Cotton supply chains are associated with high operational costs for delivery and the storage of goods across the globe. The trading company takes on the funding of goods during transportation or storage of cotton for fabric mills that are trying to optimise their storage costs and inventory holdings. As for farmers, the trader provides credit lines for future crops to support their operations.

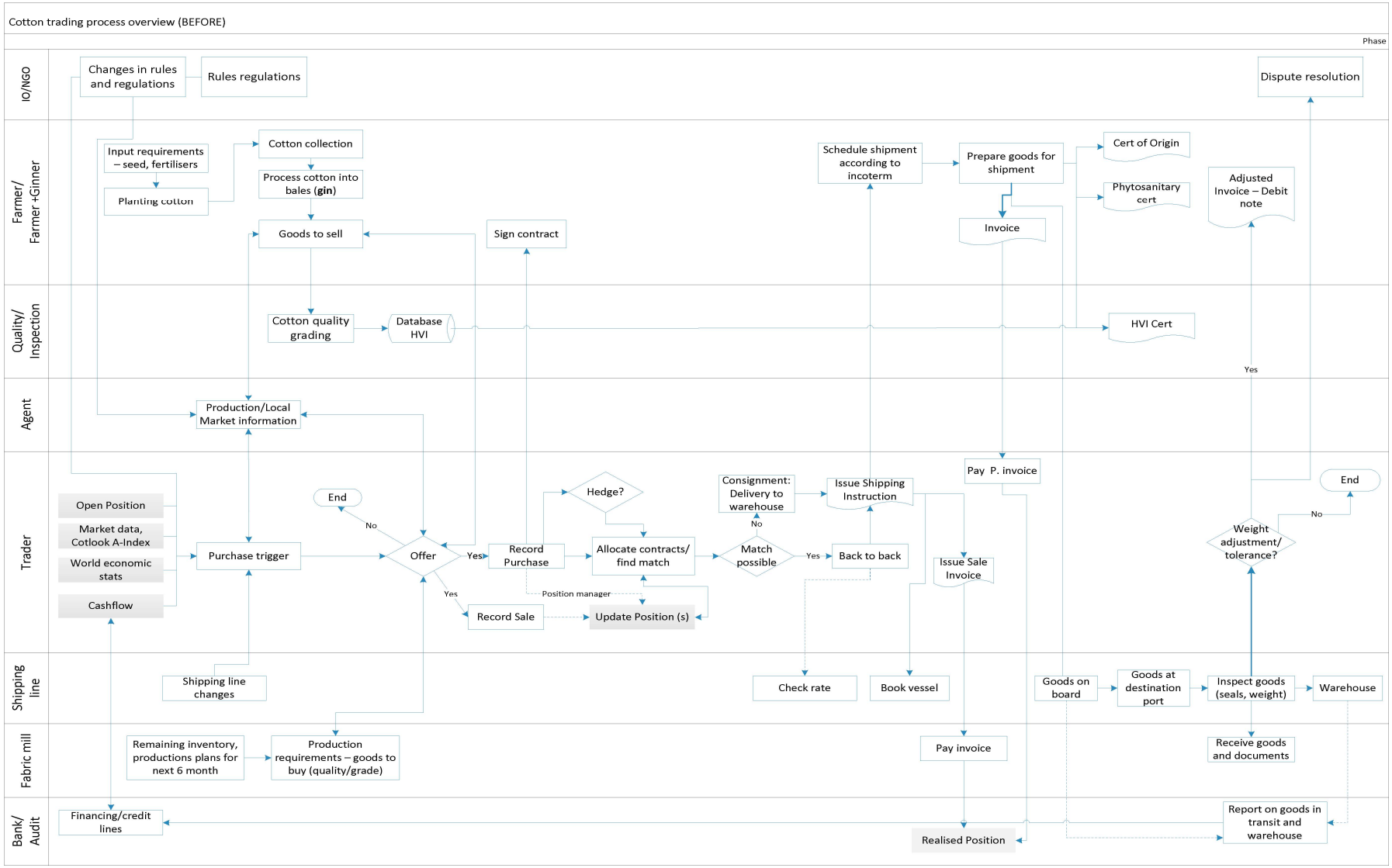

Figure 4.33 Cotton trading process overview (CS3 'Before')

4.3.6 New DSS Architecture CS3 'After'

The company went through the task of mapping out processes and found that some of the tasks and processes have been replicated three or even four times by different employees. The prospective vendor for a new information architecture solution gathered the requirements for the business needs and processes which were then implemented into a company-tailored, information management solution further integrated into company operations. The design included organisation specific customised features and the possibility for further functionality changes.

The main drivers for the change in the information management system for the company were the optimisation of processes and the elimination of replicated tasks. Secondly, the new system should allow reduced errors in data entry and documentation that could lead to severe shipment and payment delays. Thirdly, it was important to reduce the opportunity of committing fraud by any traders within the organisation and improvements/facilitation for company auditing.

> "*When our market experienced the increased volatility explained earlier, it was very clear to us that we had to devise an IT system which covered the A to Z of our business and one which was visible and transparent across the corporation and one which could clearly help decision making around our trading areas, volumes, customer limits, shipment book and accounts*" (CS3I2).

Some of the main requirements for the new information management system to support cotton-trading operations included:

1. Bale-by-bale inventory management – every bale can have its own characteristics, ensuring consistency of quality across all bales in the lot
    a. Inventory sorting by quality, weight and location. Inventory sorting in stock ownership type – loan, equity or cash;
    b. Inventory locations overview – inventory and logistics optimisation
    c. Import/Export Electronic warehouse receipt (EWR)
    d. Import/Export Permanent Bale identification tags (PBI)
2. Ability to 'reserve bales' – exclude from available inventory
3. System saved pre-set company standard reports

4. Allocations and dates tracking for shipment and delivery. Keeping record/history in cases of claims
5. Import of 'take up' lots – characteristics provided by the supplier
6. Accounting and payments records for inventory purchased and paid for and inventory sold and paid by customer.
7. Hedged position – commodity futures bought and sold to minimise the risk of price changes of physical goods.
8. Inspections and weight changes – 'weight franchise'
9. Invoice accruals (estimates) and comparison with actual costs – 'actual vs budget report'
10. Usage/application by other participants in the SC (US Shippers) – more developed governance

The system was tailored to the specific needs defined by the customer at the start of the project. The change was positively received by the staff and did not cause disruption to the business due to the specific customisations prepared and the amount of automation it brought to the business.

> *"We put together a team from the various functions, trading, trade execution, finance, IT and office services to put together a flow chart of our current state of business and all of the flows within it. The number of duplications and even triplications of work was mind boggling and immediately needed addressing. Our system was outdated and we found a partner to work with to effectively custom make a system for our business. It took over two years to put together but we firmly believe that any new employee could now walk into our business and gain a very good understanding within a very short time*" (CS3I2).

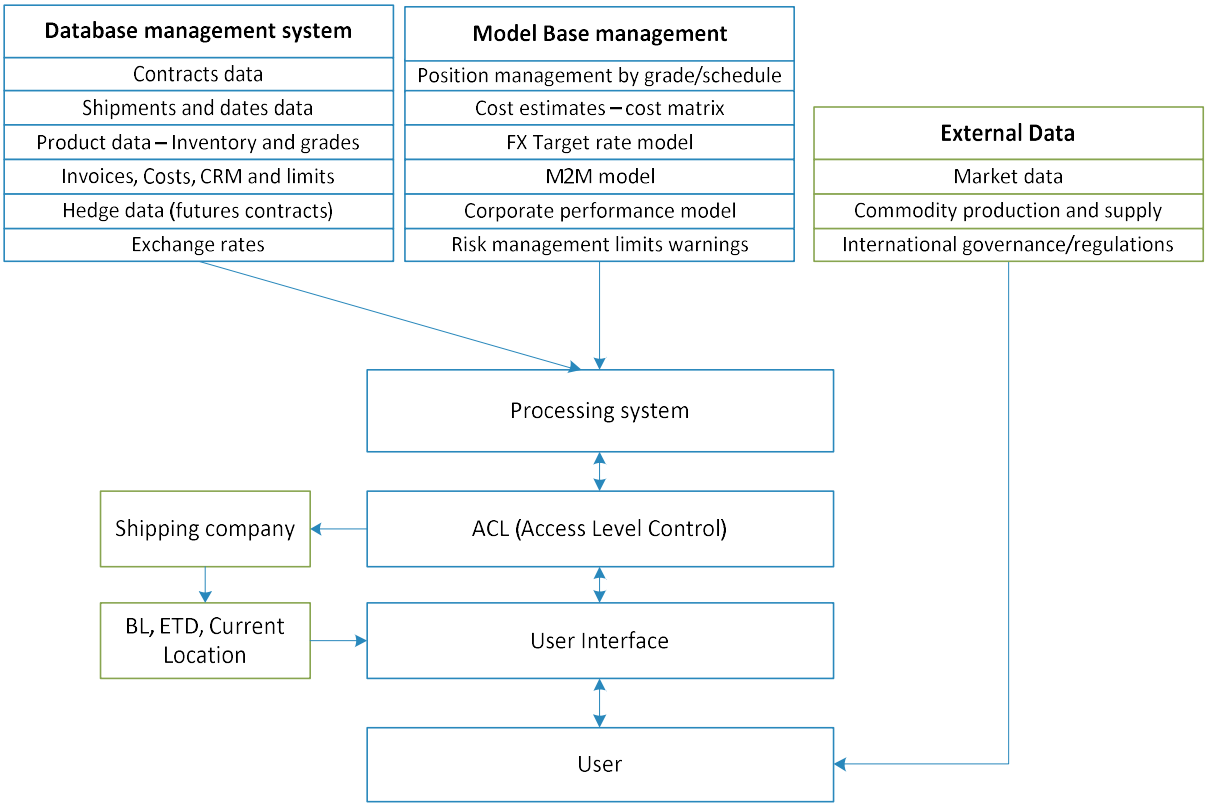

Figure 4.34 New information management architecture (CS3 'After')

The system was designed specifically for this company and included the features of third-party access for viewing the data or entering data (dates of shipment, BL numbers, etc.).

4.3.7 Company Operations CS3 'After'

A quick trading cycle time is the main goal for any trading company. The reduction of time between payment issuance to the supplier and receipt of finances from the buyer is important in assessing efficiency. The company's goal was to improve efficiencies across all company operations. At one point, the company agreed with the bank to 'open a branch' – place one of its staff into the trading office to help with documents clearance and processing to save time for documents transfer. One other example was the integration efforts with shipping companies. Additional functionality to the DSS was implemented to allow shipping lines to log into the system to enter BL numbers, ETD and the current location of goods.

In some cases, the company managed to organise a supply chain in a way that they would receive payment from the customer before they pay for goods themselves, reaching a positive credit balance. Numerous factors attributed to this, including payment terms on the contracts

and fast document processing. Such performance could not be fully attributed to the new information architecture but it certainly played a role in improved efficiencies.

> "*When we rolled out our new system, in order to be as transparent as possible, we immediately agreed that we had to roll this out to our counterparts across the business as we knew that we were implementing some fundamental changes across our business which would impact many of them*" (CS3I3).

The internal collaboration between departments improved too. Different departments in the organisation did not always understand the specific requirements and challenges for the trade desk, logistics or finance. It was common for information to be partially entered by the trade department and inaqdequately executed by another department, creating frustration and under-performance. The overall visibility of data across the company increased personal responsibility for the information entered in the system and resulted in a 'mental change' of the employees and a better understanding of the needs across departments.

> "*I never thought that I would see the day when a system had so much influence on our daily decisions and it brought to mind on many occasion a quote I have used presentations by Heraclitus – "There is nothing so constant as change""* (CS3I3).

4.3.8 Supply Chain Governance and Visibility CS3 'After'

The business requires continuous audits to comply with the corporate governance code. Corporate governance is important because it explores how decision makers act and what the basis is for the decisions and actions undertaken. The audit statements are published to show company performance to the public. The introduction of an automated numbering system for contracts, shipment and invoices was an important step to prevent fraudulent activities and provide proof on compliance with the regulations.

> "*Gone are the days when a trader would confirm a trade in the telephone based on relationship alone. No matter how close a relationship may be, business is now based around contract limits and one key factor of our new system is that we can also see how much cotton we have 'on the water' to each and every customer at the lush of a button, enhancing the information needed by the trader to say yes or no to a possible trade*" (CS3I2).

Every contract number needs to be accounted for and the deals could be entered ad hoc into system when it was convenient for the trader. There were cases when the contract would be agreed, but not entered into the system until it is more favourable for the trader's position to do so. Additionally, the introduction of an auto numbering system was a great improvement especially due to the company having two subsidiaries in the UK and US so the activities between offices became more synchronised.

> "*We now have a system which our auditors, complimented us for as they saw it as a system which covers every single part of our business in a way that flows through each function fluently and transparently with minimal chance of any problems which could bring a financial hit. A system which prohibits us from confirming a trade if any of the numerous limits, volume and financial, are exceeded*" (CS3I2).

The system also helped with safeguarding from making contracts with the companies and origins that could be under sanctions lists like Iran. It's only the goods from the origin that could not be traded, but even delivery routes would have to be altered. Some contracts could be agreed through agents or for trusty long-term relationships between counterparts, but it became restricted by the system.

4.3.9 Risk Management Policy and Procedures CS3 'After'

It was mentioned earlier that the changes in the company risk management policy and, management of supply chain partners, were driven by the severe effects (losses) brought about by the economic crisis. The crisis of 2008 led to a critical drop in cotton prices and a loss of credits issued to companies, which led to numerous future contracts agreed on high prices that were un-realised. A company risk management committee was established and new policies were developed for better controls in the future. However, it was recognised that the new information systems architecture played a significant role in enabling this change.

> "*In order to minimise such a hit, we have introduced daily trading limits in virtually every part of our business. For example:-New York Futures - a limit as to how much we will trade in one day and stop loss orders if the market moves severely against us thereby allowing us to exit our position in an orderly manner*" (CS3I1).

The new, stricter risk management policy included an introduction of operational and credit limits for trading with suppliers and customers. It was decided that the amount of business made with the partners should not exceed 20% of their overall production. Easy set up and clear visibility of counterparty limits at the time of entering a contract prevented rushed and un-justified decisions.

> "*Customer limits - due to the above factors a severe market movement could mean that contracts move into a major profit situation for us but in turn the risk that a customer could 'walk away' from a contract therefore leaving us with a contract which, whilst we could move to arbitration to have such a contract honoured, it is likely to be a paper award which we would then have to fight, possibly for many years, before recovering anything. We now have a contractual dollar value on how much trade we are prepared to have outstanding with each and every one of our customers worldwide, which currently amount to in excess jof 1,000!"* (CS3I2).

The change also concerned company position management. Personal reports have been eliminated, and a single centralised position report that could be accessed by the executive board or other traders at any time was developed. This increased the traders' responsibility for deals and data entered. The speed of processing, quality and completeness of data in the system allows for much faster and more accurate position management and in turn more reliable decision-making. The information that was now available to traders in the system allowed them to analyse opportunities for hedging and taking on long-term commodity tenders including regular deliveries of commodities up to three years ahead. Even though such long-term contracts are no longer commonly used due to changes in market conditions since 2008, there is high pressure to make more regular short-term contracts, hedges and goods valuation to ensure profit.

As part of greater controls and risk management efforts, traders were now required to be more involved in the entire process of the trade cycle from contract to the point of receipt of payment. Increased responsibility to overlook the entire process required effective communication and better synchronisation between departments. The new information architecture allowed this to happen. The communication between logistics and trade departments on any specific requirements and deadlines improved, reducing frustration and staff mistakes.

"*This new system has improved our decision making to a major degree and every member of our team has full knowledge of the A to Z of the business*" (CS3I3).

Overall, the controls for various risk management aspects of trade improved because of records and the history of events and actions undertaken on the day. Compared to the previous information management architecture controls over any procedures were very limited and edits could not be traced. The new system brought in more checks and restrictions from making deals that seemed 'too good to be true' and put in place safeguarding measures from the severe effects of changes to the economic situation.

"*We have introduced a fortnightly call across our cotton offices across the globe to discuss each and every outstanding contract, a summary of all shipments, the dollar amount at risk if contracts fall through and a detailed review of our attempts to recover monies were contracts fell into question*" (CS3I2).

4.3.10 Access to Finance and Company Performance CS3 'After'

A significant part of international trade is conducted through Letter of Credit (LC). The LC procedure requires accurate and timely documentation management and processing. Document management has improved due to the reduction of data error, a single database of company and peoples' names, addresses and any other relevant information. Moreover, utilising automated system templates reduced the time required to generate these documents.

An attempt was made to allow counterparties to enter their LC details directly into the commodity trading system to streamline document checks and processing/delivery time. However, this first effort was unsuccessful and suppliers were not interested. In the complex network of upstream supply chains it is difficult to know the reason, but it was perceived as a need to keep their power in providing their own LC templates.

As for company cash flow and access to finance by securing credit lines with banks, the direct link between the new information architecture and the relationship with banks was not found. However, the speed and quality of reporting helped process any company and bank requests for documents or information much quicker.

> "*Banks and auditors saw this as a major step in the right direction and one which would put many of the risks previously associated with the business under our own control*" (CS3I3).

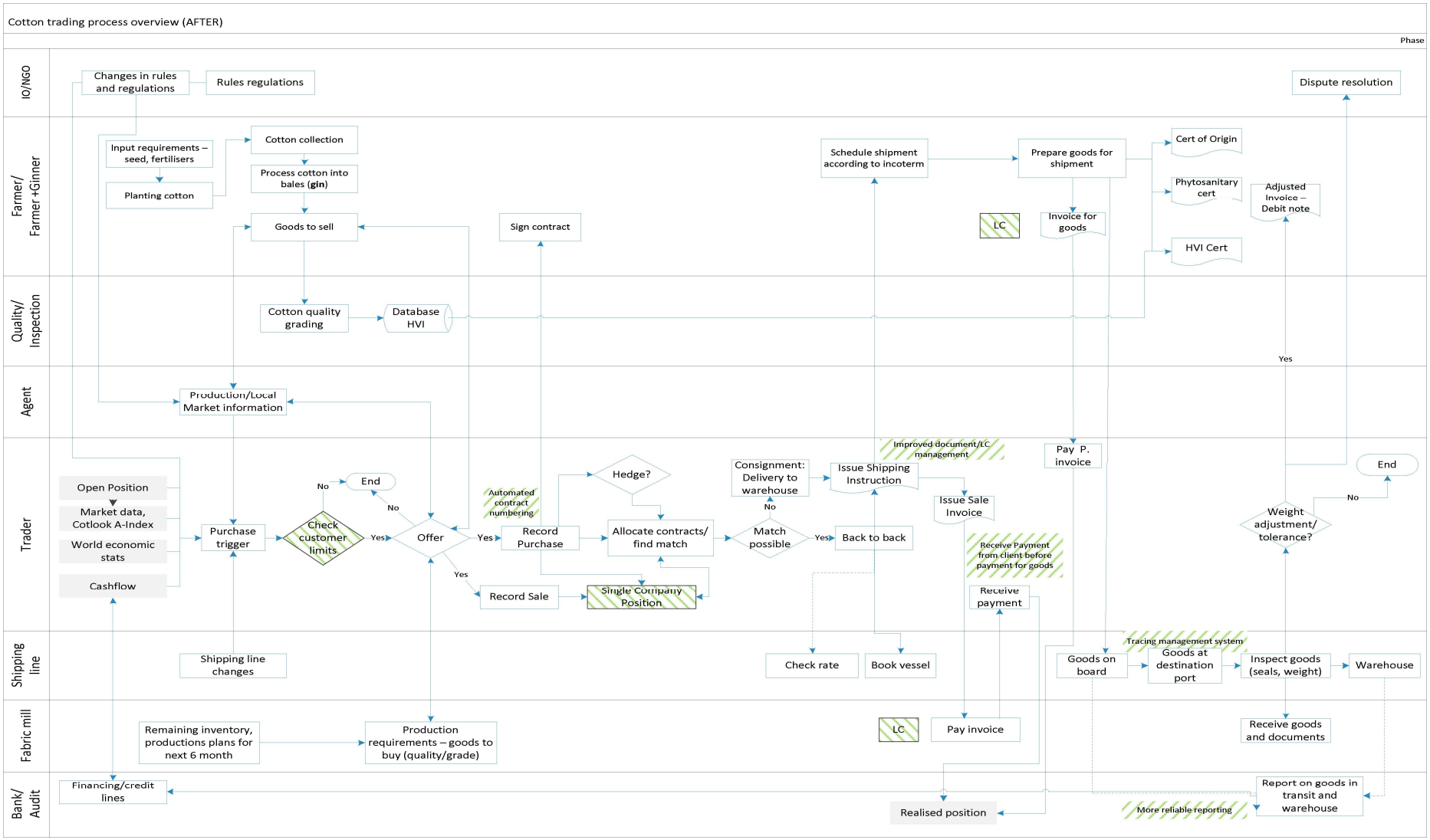

Figure 4.35 Cotton trading process changes (CS3 'After')

Table 4.7 summarises the findings from case study 3.

Table 4.7 Case Study 3 Findings

	'BEFORE'	**'AFTER'**
GOVERNANCE	Relational governance – trust, long-term relationships	1. Transactional governance – internal controls and operations streamline (automated numbering and corporate governance compliance) 2. Supply chain governance - compliance with international regulation and country restrictions due to sanctions, etc. 3. Contractual governance – counterparty performance assessment, performance incentives.
RISK MANAGEMENT	Personal judgement Multiple Individual positions	1. Trading/operational limits per supplier and customer 2. Single Position sheet and global company exposure
TRADE FINANCE (ACCESS TO FINANCE)	Reliance to past performance in relationship with bank, trust and reputation	1. Document management 2. Reports to bank
OPERATIONAL EFFICIENCY	Verbal and written causing errors due to lack of communication	1. Automated reports 2. Automated documents 3. Shipping companies accessing system

5 Chapter 5 Cross-Case Analysis

Through the presentation of the findings in Case Study chapter (Chapter Four), the role and operations of intermediary commodity traders has been reviewed and evidence of challenges in upstream supply chains presented. The finding of the impact of changes in information management architecture by implementation of decision support system were presented through 'Before' and 'After' commodity trading process maps. This section will review the findings across three case studies and provide cross-case analysis. The section begins with a presentation of all main activities involved in commodity trading cycle before discussing the specific challenges which influence company's and supply chain performance. The summaries of information management architectures and changes introduced with DSS presented and compared among case studies.

5.1 Intermediary Trade Cycle Overview

The study explored a range of processes related to trading business cycle including trading and negotiations, pricing and valuations, allocations, and logistics and delivery, invoicing and payments discussed in detail in Chapter Four. After careful analysis, following conclusions made:

- It was established that companies are focusing to improve supply chain governance and internal controls when deciding to implement DSS
- All case study companies recognised the advances in operational efficiencies
- The evidence of improved business processes controls, reporting and analysis can be used display reliable business operations in order in increase credit lines from the banks
- The risk management enhanced by improved visibility of the current position reporting and customer/supplier performance and trade limits set up.
- Overall decision making improvements based on availability and accuracy of data

5.1.1 Operational Efficiency Improvements

The perceive usefulness of a system on the processes of commodity trading and delivery were revealed by asking questions relating to the functionality requirements, and direct questions of the effectiveness of the system in cost, inventory and shipment management.

Fig. 5.1, 5.2 and 5.3 and Table 5.1 summarise the trading processes of three case study companies.

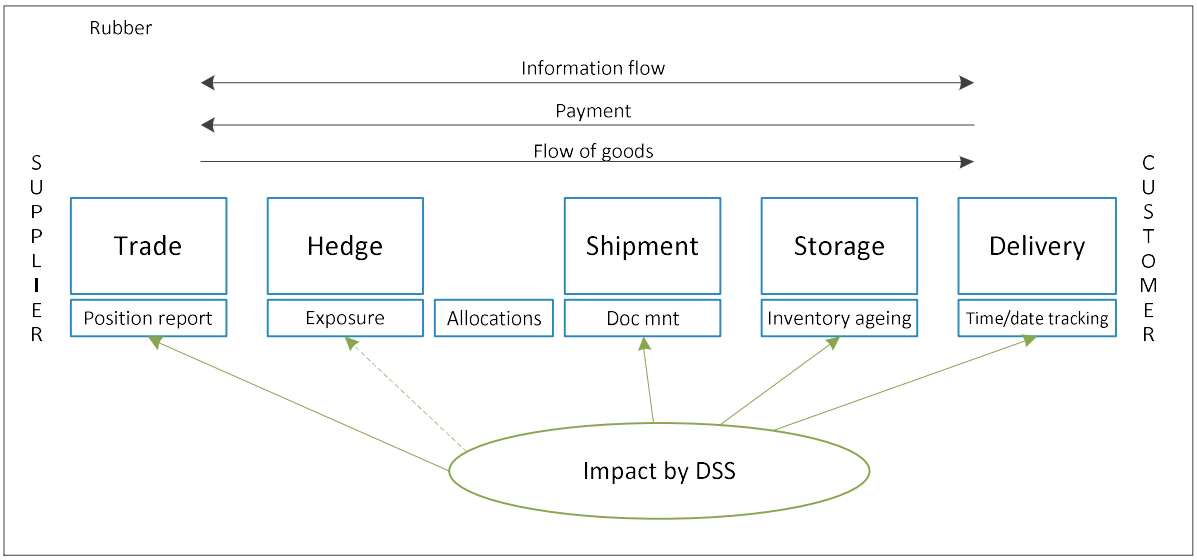

Figure 5.1 CS1 Summary of the core business process

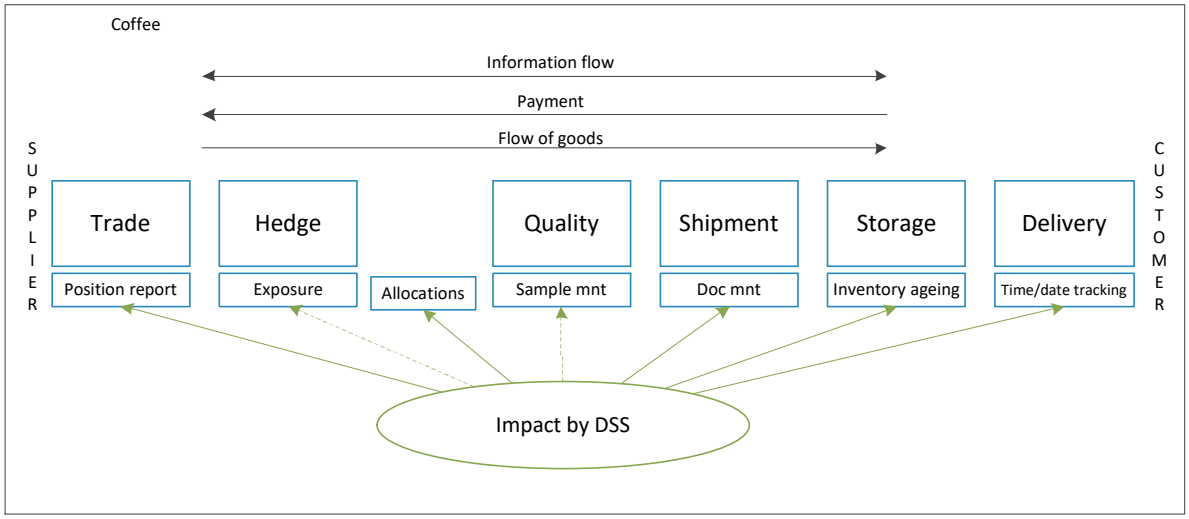

Figure 5.2 CS2 Summary of the core business process

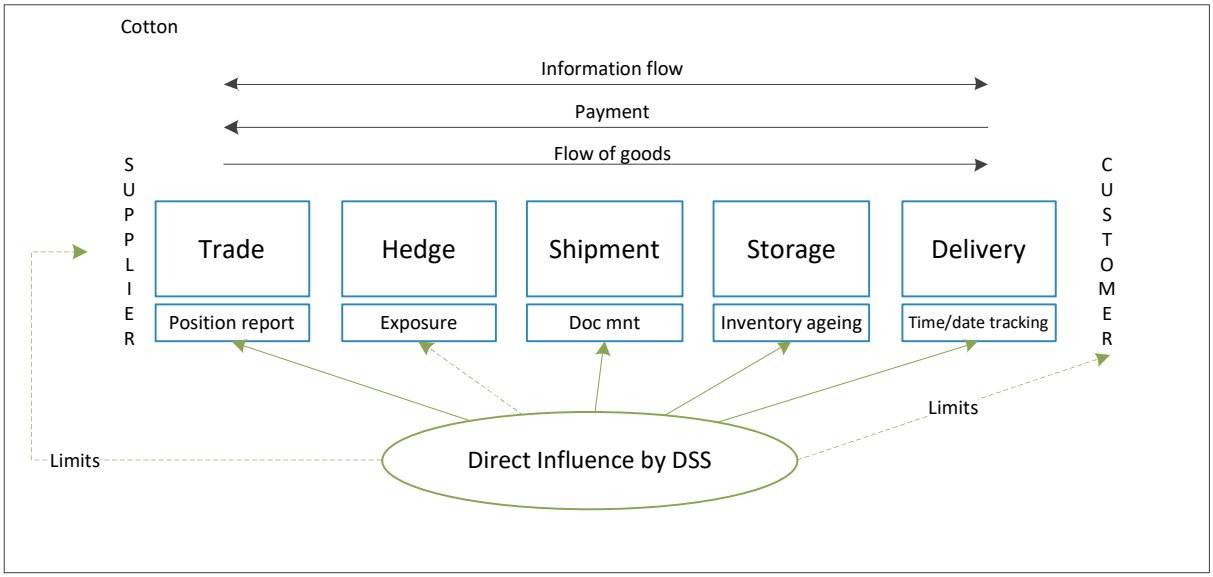

Figure 5.3 CS3 Summary of the core business process

The perceived impact of DSS – trading management system on company operations have been displayed by connectors on the diagrams. The changes in operational efficiency have been mostly found in shipment, delivery and document management processes. DSS allowed reducing the times on creating documents, sending the documents to the stakeholders and creating operational reports (inventory reports, customer update reports, position changes reports). The quality of data have also greatly improved reducing the time on correcting/investigating the errors.

As for the trading operations of the businesses, 'position report' feature recognised as core decision-support tool for trading companies and increased the speed of analysing the data, however, data entry and maintenance have been found more demanding from the trade department because staff was now required to enter more detail about every deal. The task hedging risks of price fluctuations on the futures market have significantly benefited from DSS by having wide visibility of the 'open' transactions (goods that have yet been paid for), shipments in execution (goods afloat) as well as historic data. However, it is relying on numerous sources of data outside such as global supply and demand, market price changes, and others, thus the impact of the DSS this process been identified with the dashed line.

5.1.2 Supply Chain Governance

Research has shown that information technology have an impact of the supply chain governance and supply chain performance (Zhang and Aramyan, 2009, Dolci and Macada, 2014). The study explored the perception of respondents in respect to the DSS impact on three governance types – transactional, contractual and relational. Respondents' perspectives were solicited by asking how they viewed supply chain visibility and traceability in the supply chains, relationships with the supply chain stakeholders and global supply chain trends and their impact on the company operations.

Table 5.1 Supply chain governance structures

CASE STUDY	TRANSACTIONAL GOVERNANCE	CONTRACTUAL GOVERNANCE	RELATIONAL GOVERNANCE
CS1	System help ensure records of goods life cycle, dates and locations	Close monitoring of stakeholder performance (payment/shipment delays)	Customer updates with up-to date information, high level of communication.
CS2	Accountability for all transaction costs through trading system	Controls of the contracted terms, accuracy and shipment/delivery estimations	Long-term plans to use trading system to allow order entry directly from customers
CS3	Company internal and external audits	Counterparty performance review	Integrated information flow for shipment ETAs with shipping company

It is believed, that change in information management architecture enabled company to increase controls over process and decision transparency and impact on transactional governance within organisation. Across all cases, transactional governance reflected in reduction of process complexity and better visibility of internal operations, including internal coordination. Contractual governance reflected and stakeholder performance reviews based on historic data. As for DSS's supporting role in the relationship between suppliers, buyers and service providers, improved customer reporting and updates with accurate information on the status of their order increase level of communication. CS3 presented an example of enabled integration of information flow with shipping agents, whilst CS1 would be considering this for the future.

5.1.3 Access to Finance and Company Performance

It is suggested that some of the factors that abstain companies from qualifying for trade finance loans include long processing time for loans, no previous transactions or lack of business relationship with the bank, burdensome documentation requirements among others (Auboin, 2016). The companies are required to show continuous and reliable performance.

The reports are provided to the bank on a weekly basis to supply evidence of "good management" of the intermediary operations.

Table 5.2 Trade finance - operational changes

CASE STUDY	COMMENT/OBSTACLES
CS1	Cashflow reporting to ensure continuous finance availability; monitoring of inventory ageing; weekly reports to bank confirming location and condition of goods.
CS2	Cashflow reporting to ensure continuous finance availability
CS3	Fast document turnover and presentation to bank, established reporting with bank

5.1.4 Risk Management Policy and Procedures

Risk management is critical competency of the intermediary trading organisations. The impact of the DSS on risk management procedures mainly reflected in the improved process visibility and up-to-date information for the decision making. The factors affecting decision making during those processes summarised in the table below.

Table 5.3 Perceived impact on risk management procedures

CASE STUDY	ENVIRONMENTAL RISK	BEHAVIOURAL RISK GOVERNANCE
CS1	Availability of hedge data contract by contract Management reports and valuation report to review previous performance and conduct forecasts	Stakeholder trade limits visibility
CS2	Company exposure visibility 'Hedge on basket' visibility of fulfilment of baskets Currency hedge targets Opportunistic/speculative hedge – cashflow and capacities to conduct speculative trades	Stakeholder previous quality performance
CS3	Position management – centralised across the company Availability of hedge data contract by contract Opportunistic/speculative hedge – cashflow and capacities to conduct speculative trades	Stakeholder trade limits visibility

5.2 Summary

Despite the differences in some of the operational management approaches, it is clear that all the case study companies are concerned with better traceability capabilities and streamlined operations. This chapter reviewed the main findings across the cases and will be basis for the following Chapter Six (Discussions).

Table 5.4 Summary of case studies' findings

	CS1 "AFTER"	CS2 "AFTER"	CS3 "AFTER"
GOVERNANCE	1.1 Transactional governance – process coordination and streamlines procedures; 1.2 Contractual governance – controls and performance assessment of sc partners 1.3 Supply chain governance – traceability systems	2.1 Transactional governance – establishing workflows 2.2 Contractual governance – improved controls over data quality and company performance 2.3 Supply chain governance - Traceability and transaction history 2.4 Supply chain governance - Easier record and report back on certified coffee traded	3.1 Transactional governance – internal controls and operations streamline (automated numbering and corporate governance compliance) 3.2 Supply chain governance - compliance with international regulation and country restrictions due to sanctions, etc. 3.3 Contractual governance – counterparty performance assessment, performance incentives.
RISK MANAGEMENT	1.4 Real time (close to real time) Position 1.5 Position break down by grades/location/etc 1.6 Standard corporate reporting across the group 1.7 More regular - weekly valuation process	2.5 Hedge record per physical contract 2.6 Visibility over company long or short position 2.7 Single Position sheet and company exposure 2.8 Stock valuation accuracy	3.4 Trading/operational limits per supplier and customer 3.5 Single Position sheet and global company exposure
TRADE FINANCE (ACCESS TO FINANCE)	1.8 More accurate and quicker reports to bank 1.9 Monitoring of ageing inventory (not older than year)	2.9 Document management 2.10 Automated reports on performance for bank	3.6 Document management 3.7 Reports to bank

OPERATIONAL EFFICIENCY	1.10 Cost management and analysis (e.g. Actual vs Budget) 1.11 Inventory accuracy 1.12 Automated documents generation 1.13 Improved internal communication	2.11 Inventory management (stock, cost and demand analysis) 2.12 Automated documents 2.13 Company processes review	3.8 Automated reports 3.9 Automated documents 3.10 Shipping companies accessing system

6 Chapter 6 Discussion

This chapter provides a synthesis of the reviewed literature with the research findings in order to address the research questions. It discusses the research findings based on data collected to identify and assess changes in company and supply chain performance introduced by DSS architecture change. The discussion builds on the work associated with the challenges of upstream supply chains influencing the performance of intermediary companies and commodity supply chains.

In this research, qualitative data was considered most appropriate to capture participants' views, thoughts, and ideas on the subject under investigation, to achieve a better understanding of each company's operations and relational behaviour between the supply chain partners. The research focused on three different cases specialising in three different commodities – rubber, coffee and cotton - which allowed the researcher to compare the results and identify the differences and establish parallels, which increased the study reliability and generalisability.

The chapter consists of three sections through which the two research questions will be addressed. The first section focuses on the main constructs of the research framework - supply chain challenges, supply chain performance, DSS in the supply chains and the overarching theory adopted – the relational view. The research framework is then linked to the research findings. The second section provides the discussion for the first research question regarding the specific upstream supply chain challenges that have an impact on intermediary trading organisations. Finally, the third section of this chapter discusses whether changes in information management architecture by implementation of DSS at the intermediary organisation had a mediating effect on the supply chain performance.

6.1 Research Summary and Conceptual Model

The summary of the underlying literature used to build the conceptual model for this study and the case study findings are presented in this section. This section elaborates key themes within this research and findings to outline the links between them.

6.1.1 Summary from the Literature on the Conceptual Model

The Literature Review chapter (Chapter Two) introduced and reviewed the main body of knowledge that provided the foundation for this work including DSS, upstream supply chains, intermediation in supply chains, and performance measurement approaches. The disciplines have been studied in the context of upstream commodity supply chains. Previous research concerning the topics mentioned has been mainly developed in marketing (Dyer and Ha-Brookshire, 2008; Purchase, 2011; Chen et al., 2013), international business (Balabanis, 2000; Jean et al., 2010; Sinkovics and Pezderka, 2010) and economics (Antras and Costinol, 2010; Ferna´ndez-Blanco, 2012; Abel-Koch, 2013; Nagengast and Stehrer, 2016) and geo-political fields of study (Quark, 2013, Pirrong, 2015). This research provides an operations management perspective to the concept of intermediation in commodity supply chains. The relational theory was adopted as an overarching theory to capture the many complex, structural and behavioural aspects of supply chain networks. Using a relational lens offers significant benefits to understand, design and manage upstream supply chains. The relational attributes such as collaborations and coordination are considered to be impacted on by the DSS. Other behavioural aspects include communication and trust.

The relational challenges found in supply chains that involve intermediaries include differences in understanding, information asymmetry, a lack of communicated strategies and policies which result in conflicting interests and cause behavioural uncertainty (Paché 1998 in Sandberg, 2017). This study set out with the aim to better understand how DSS in upstream commodity supply chains can help manage various risks and provide improved business and supply chain visibility and performance. The overarching theory was chosen to address one of the main features of upstream supply chains – the complexity (Bode and Wagner, 2015) -

and is in line with the notion that relational attributes impact performance (Fung et al., 2007). The research conceptual model is presented below Fig. 6.1.

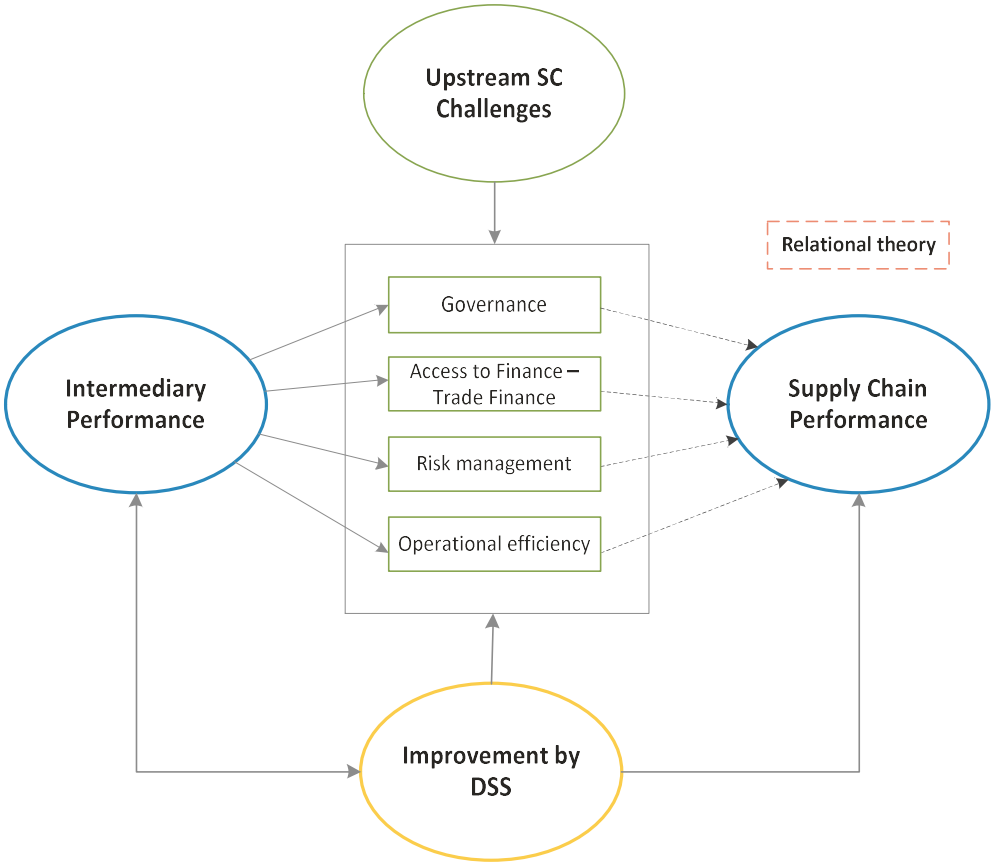

Figure 6.1 Conceptual Model

In a global business environment, companies seek to improve or sustain their competitiveness by adopting DSS. The decision support systems in the supply chains are used to supply decision makers with appropriate and accurate information and prospectively the ability to predict the outcome of the decisions and their impact on the entire supply chain (Hilletofth et al., 2016). The performance influencing factors of DSS and IT overall have been widely discussed (Philips-Wren et al., 2011, Ben-Zvi, 2012, Chang et al., 2015). The benefits are linked to the effectiveness of, or improvements in, business processes because firms have access to more timely and accurate information (Wu et al., 2006; Zhang et al., 2013) as well as, increased visibility and improved decision making (Simatupang and Sridharan,2005; Adebanjo, 2009; Caridi, et al., 2014). The decisions made by intermediaries to buy or sell, and

hedge or not hedge, rely on timely (close to real time) information as well as the trader's personal judgement (and have relational aspect too) (Fok, 2006; Kanda and Deshmukh, 2008; Martınez-de Albéniz and Simón, 2010). Additionally, it is claimed that DSS improve coordination and facilitate cooperation with suppliers as well as improve responsiveness to market and customer specific requirements (Spulber, 1999; Wu, 2004; Abel-Koch, 2013; Adida et al., 2015) and collaboration (Bartlett et. al., 2007; Saldanha et al., 2013; Hernandez et al., 2014). In this research, the DSS are examined to help intermediary organisations improve decision making to best manage supply chain risks and maintain the value adding activities to the supply chain. Interest have been shown in the application of integrated DSS across the supply chain participants. However, difficulties in implementing integrated DSS are derived from the upstream supply chain complexity - institutional and regulatory pressures within upstream supply chains (Quark, 2013), limited flexibility due to lead times/long distance transportation times and a decentralised environment due to cross-border transactions, trust and cost of the systems makes the adoption of such DSS across entire supply chain limited (Bode and Wagner, 2015).

The research focuses on the specific context – upstream commodity supply chains and looking at identifying the core challenges that have an impact on the supply chains. Four categories of the supply chain challenges have been distinguished from the literature: supply chain governance, access to finance, risk management and operational efficiencies. A variety of issues with upstream supply chain governance have been raised in the literature, such as the introduction of new specific standards in the supply chain which implies new procedures and contract rules (Quark., 2013), audits and certifications of suppliers at all stages of the supply chain (Ghozzi et al., 2016). The adoption of new standards and certifications can impact governance structures and vertical relationships in supply chains (Ghozzi et al., 2016). The intermediary's knowledge and compliance with the state and international requirements are critical for viable performance and allow for more seamless transportation of goods across the globe. With the implementation of designated decision support systems there is an opportunity to provide more robust and traceable processes of the intermediary transactions and operations.

Secondly, it has been demonstrated in the literature that access to finance by the supply chain participants to support their operations is critical for international trade (Beck et al., 2007).

The difficulties with accessing trade finance are related to the risk factors associated with the countries engaged in the international trade. The producers of primary commodities are often located in poor countries that have restricted access to finance to facilitate the trade (Auboin, 2016). Intermediary trading firms are continuously seeking financing from banks to support their operations and ensure continuous trade (Kowit et al., 2016). Applying advanced DSS could overcome inefficiency and provide instruments for constant review of company operations and reliable performance to the bank to ensure credit lines issuance. Trading intermediaries in the upstream supply chains are often providing smaller credit for their supply chain partners to support their processes (Quark, 2013).

Thirdly, risk has been recognised as part of every business environment whilst global development is creating new risks (Giunipero and Eltantawy, 2004). Various sources of risk have been highlighted – security risks (Giunipero and Eltantawy, 2004); market volatility (Pirrong, 2010); operational risks including inventory holding (Kouvelis et al., 2013), cost pressures (Tang, 2005) and supplier and buyer risks (Chen et al., 2013). Intermediaries in supply chains are aiming to reduce these risks and enhance competitive performance by closely integrating company internal functions with external operations of suppliers and final customers. Risk management processes and capabilities are extremely sensitive to the environment and their success is dependent upon company strategy, root-cause of the problems solved, local market and business conditions of specific transactions.

Operational challenges in the upstream supply chains are related to shipments' scheduling, inventory (Jain et al., 2013; Kouvelis et al., 2013) and cost management; as well as capacity assessment (Secomandi, 2010). Advancement in operational efficiencies should allow for reduction of trade cycle times and quicker finances turnover within given period. Improvement of operational efficiencies by the implementation of DSS have been discussed (Shah & Shin, 2007; Mishra et al., 2013). In this research, the dynamic context, and relational aspects play an important role in managing operational efficiencies and the prime focus concerns information management architectures to support decision making.

Finally, the literature chapter reviewed the various approaches to performance measurement. Performance has been studied from different perspectives. Some researchers have examined company performance in relation to the effectiveness of specific supply chain strategies by using specific measurement units such as overall product quality and customer

service levels (Gunasekaran and Kobu, 2007); others conclude that business performance should be based on financial and accounting data because firm performance is affected by the firms' securities (Shao et al., 2012). Moreover, metrics proposed by the supply chain management literature are related to cost, time, flexibility, and customer responsiveness. Gunasekaran et al. (2004) proposed metrics based on four criteria – to plan, source, assemble and deliver. The authors also examined how SCM relationships (collaboration and integration) affected firm performance (Jean et al., 2008; Sinkovics and Kim 2014). Additionally, the literature in global sourcing claims that supply chain performance can not only be assessed based on traditional logistics performance metrics such as total cost, service and lead time, but should include environmental and sustainability issues (Astuti et al., 2015; Luzzini et al., 2015; Busse, 2016).

Some of the more established and empirically used performance measurement metrics include SCOR (Bolstorff and Rosenbaum, 2003), Balanced scorecard (Callado and Jack, 2015) and activity based costing (Bevilacqua et al., 2009). Specialised metrics addressing agricultural supply chains have been developed by Aramyan et al. (2006). It was recognised that the metrics should address the characteristics and be in line with company strategy, otherwise the number of variables to measure the performance can get too large and lose their usefulness (Gunasekaran, 2001). Dolci and Macada (2014) highlighted the impact of relationships in supply chains on two levels - operational and financial. In this study we have adopted a variety of metrics focusing on those two aspects – the ability to effectively manage physical flows of goods – operational - and maintain creditworthiness and cashflow – financial metrics. Moreover, there are numerous studies which review how connections between buyer-supplier relations are aimed towards integration and greater collaboration and improved performance. The relational attributes of communication, trust, supplier involvement and sales volume can affect performance and relationships of partnering firms (Wang, 2012). Measuring the impact of risk management practices is more difficult (Hoffmann et al., 2013; Chopra and Sodhi, 2004, Cantor et al., 2014). This study uses the participants' assessment of the risk management improvements.

After providing a brief summary of the main concepts and ideas developed within the Literature Review chapter (Chapter Two), the following section of this chapter provides a summary of the main findings.

6.1.2 Summary of the Findings Around the Conceptual Model

To answer both research questions, a qualitative research by means of multiple case studies was designed as detailed in Methodology Chapter (Chapter Three). The data was collected and analysed using semi-structured interviews, on-site observations, and available and appropriate documentation. The collection and analysis of qualitative data enabled the researcher to gain a better understanding of the upstream supply chain trading processes and identify the challenges based on the participants' views and experience (Creswell, 2013). The process mapping of intermediary's operations allowed the researcher to draw a picture of the modifications in processes introduced by the information management architecture changes.

The revised conceptual model of the research presented in Fig. 6.2 summarises the findings from the literature review and case studies about the impact of DSS at intermediary organisations on business and supply chain performance. The review of the decision-making process was at the centre of the improvements introduced by the DSS. More specifically, the ability of decision-makers to make quicker, more accurate decisions to buy or sell commodities at the best price whilst complying with rules, regulations, the company's strategy and the customer's requirements is reviewed. The processes at the intermediary trading companies that were considered in the study include trading operations, pricing and valuations, allocations' consolidation, shipping, and logistics operations. Furthermore, sustainability and traceability efforts as well as risk management policies by the case study companies are discussed. The process mapping was undertaken in order to further understand the relationships between the functional departments within the organisation and with external partners and service providers.

It was established and confirmed that organisations' drivers for implementation of the information systems were: 1) improvement of consistency and robustness of the organisation's processes and operations traceability in order to demonstrate compliance with state and international trade regulations; 2) develop mechanisms/reports to increase company credibility and opportunities to apply for finance (present reliable operations and risk management policies); 3) improve visibility of performance history and increase robustness of company risk management policies to contribute towards the decision making

process; 4) deploy mechanisms to ensure alignment of departmental strategies in terms of organisation's performance targets (KPIs).

As was discussed in Case Study chapter (Chapter Four), all the cases recognised that, DSS play a strategic importance in the organization's competitive advantage and ability to maintain or advance their position in the market. In all three cases, the Commodity Trading Management systems were customised to the specific requirements and companies' needs. In the Case Study 1, the DSS was adopted as an upgrade from the legacy system used previously to overcome several issues: improving internal efficiencies and streamlining operational processes; supporting expanding business operations and managing different commodities traded by the company in one platform. Case Study 2 implemented the system to overcome an evident lack of alignment between the different departments, and consistency in business records and historic data, which was hindering the rational performance assessment and limiting opportunity for business growth; fulfil the need for more consistent and robust analyses of hedging operations to improve decision-making processes and the rationale behind it. Case Study 3 used DSS in order to enable operational optimisation and the reduction of duplicated processes as well as increasing the company's corporate governance compliance.

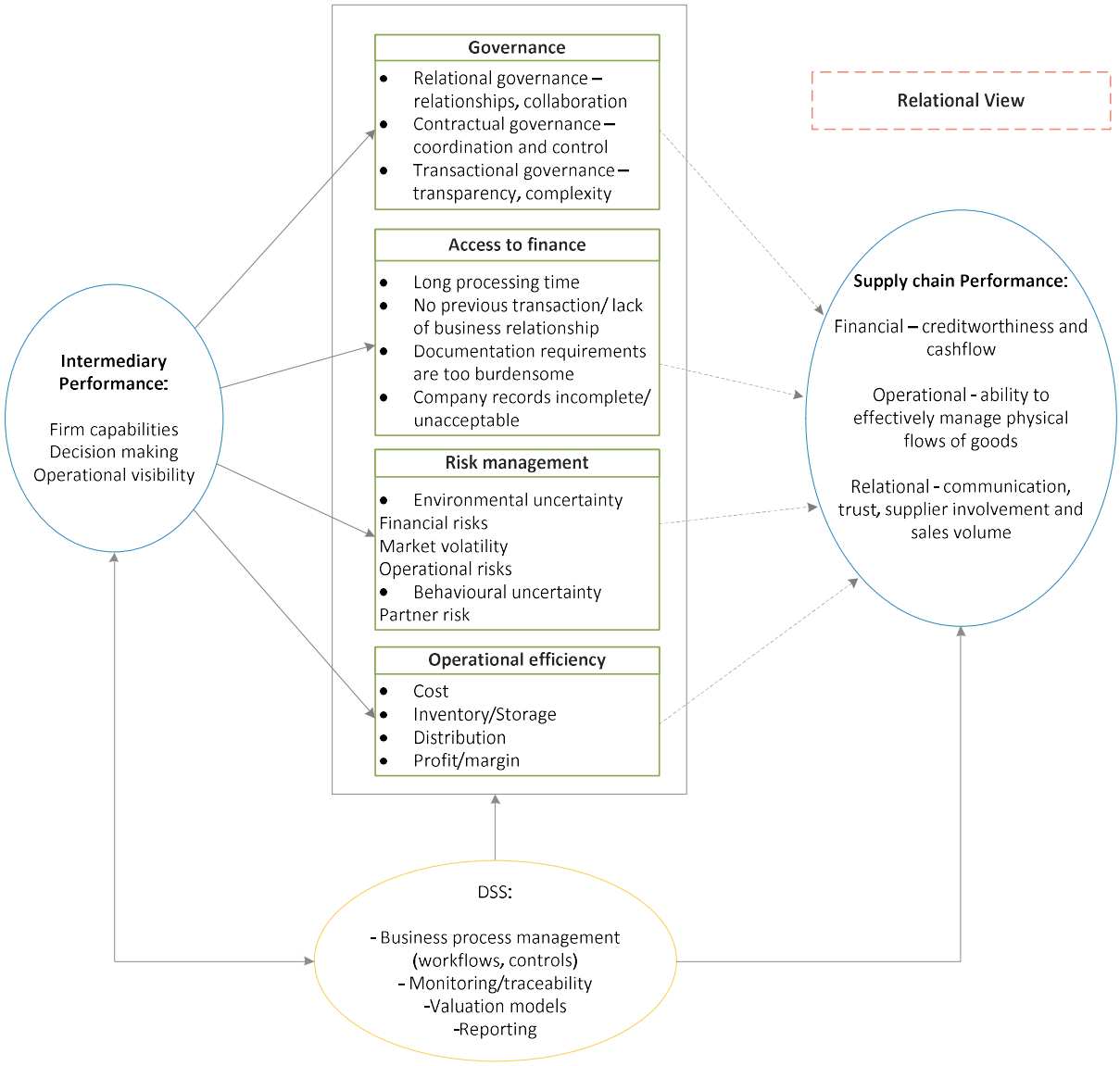

Figure 6.2 Revised Conceptual Model

Having summarised the literature reviewed and the findings from case studies, the following section will focus on answering the research questions.

6.2 Research Question 1

This section of the discussion chapter will address the research question 1 as detailed in Introduction chapter (Chapter One):

> **RQ1** What are the core, performance influencing challenges of upstream commodity supply chains and how can these challenges be addressed or exacerbated by the actions of intermediary traders?

From the analysis of the literature review and case study findings, it was established that the globalisation trends are the driving force of supply chain development, but that also create number of challenges in modern supply chains. First set of issues is related to the supply chain governance: traceability of goods back to their country of origin (Tong and Wei, 2014; Ibrahim et al., 2015); issues related information sharing and collaboration among supply chain partners (Popp, 2000; Samaddar et al., 2006; Goswami et al., 2011); and finally, supply chain regulations, arbitration and contract rules (Kaplinsky, 2005; Quark, 2012). The next set of issues identified from the literature uncover the financial obstacles in the upstream supply chains and specifically access to trade finance by the supply chain participants (Auboin, 2016; Kowit et al., 2016). The challenges related to the long distance transportation and large volumes of goods stored incorporated into the group of operational of challenges (Klein and Rai, 2009; Secomandi, 2010). Finally, uncertainty of the upstream supply chain environment and market volatility form last group of challenges uncovered (Pirrong, 2014; Kilubi and Haasis, 2015). The issues identified are closely intertwined and do not allow to draw clear boundaries between them or in other approaches merged together, but this categorisation adopted to achieve sufficient level of detail for this research to provide contributions to knowledge as well as practitioners.

It was found that the upstream supply chain network has multiple embedded social and institutional players (such as international organisations (WTO), and industry specific organisations (ICA), as well as national authorities and regulations) and these relationships affect the economic development across the entire supply chain (Bair, 2005). Previous research found that participants of the supply chain with greater power are generally trying to change the rules of that supply chain that will effectively allow them to helped to dominate

that supply chain by creating new institutions that serve their interests instead of building institutions that enhance market discipline (Quark, 2013). The analysis of social constructs within the supply chain is extremely beneficial for the achievement of their primary goals. The GCC framework helped to define and map supply chains and identify the dynamics, trends, network and relationship structure in commodity supply chains.

Governance have been defined in the literature as a set of choices that control how the organisation establishes relationships between management, including the executive board, stakeholders, shareholders, partners and regulators (Heart, 2010). The definition can also include "all the influences affecting the institutional processes, including those for appointing the controllers and/or regulators, involved in organizing the production and sale of goods and services" (Turnbull, 1997, p. 181 in Heart, 2010). The governance has been recognised as one of core challenges in the upstream supply chain management and have been confirmed by the case studies. The compliance with supply chain regulations is critical for effective and seamless execution of cross-border transactions. Transactional governance is focusing on reduction of complexity in the operations of intermediary trading organisations and improved visibility of operations in order to reduce transaction costs.

Contractual governance is reflected in number of feature for the intermediary trading companies. This type of governance is especially important in upstream supply chains because of common conflicting interests (price) between partners and highly opportunistic behaviour in upstream supply chains. The solid contractual governance of the operations allow for better coordination, control and analysis of the stakeholder performance and prospective risk management targets. Moreover, contractual governance help demonstrate intermediary compliance with Corporate Social Responsibility and other sustainability initiatives and can play a decisive role for many retailers in their sourcing decisions through intermediary organisations (Robinson 2008; Jonsson and Tolstoy 2014).

The relational governance play an important role in the upstream supply chain performance by enhancing collaboration, trust between partners and commitment to good performance. Claro et al. (2003) showed that inter-organisational trust, information sharing and physical transaction specific investments have a positive impact on joint planning, and supply chain efficiency. The cases agreed on the importance of the relationships with supply chain

partners, regular meetings, provision of updates for their orders. Case Study 3 in their experience made an investment into the functionality that would allow shipping companies and shipping agents to update shipment information within intermediary via DSS. This allowed for improved shipping and logistics efficiencies. The other two cases recognise the opportunities of such investment, but value and return are hard to quantify in monetary terms.

The governance issues can be closely associated to the challenges of trade finance and risk management, but for the purpose of this research they have been distinguished into separate categories. Trade finance function is mainly associated with the communication and negotiations with the bank. The intermediaries need to show consistent operations and strong controls over processes and procedures. The DSS show reliable source of evidence for the financial institutions to assess performance and controls in place to avoid losses of funds or defaults.

Risk management by intermediary organisations is performed at all stages of trade processes – from contracts with suppliers and customers, hedging, selection of service providers, shipment and logistics of goods and so on. The most discussed risk management tool is Position Report. The DSS help intermediaries manage open physical and futures (hedges) position in a single report.

Effective management of the shipments, storage and deliveries of goods as well as documents management allow for timely transportation of goods across the world. Inventory holding in the supply chain may cause a cost and service based conflict between retailers and their suppliers. Whilst retailers prefer late ordering in order to avoid demand uncertainty and inventory speculation particularly on seasonal products; suppliers prefer longer lead times to better optimise and manage their production capacities (Sandberg, 2017). The timing of orders becomes about balancing amounts of inventory holding by retailer and supplier. Intermediary trading organisations essentially manage the inventory for their partners. Shipments scheduling and warehousing of goods for customer convenience minimises risks of disruption to the manufacturing process and reduces risks of wrong orders, container loads, customs clearance, and capital investments into long term storage. The advantage of intermediaries to handle those operational tasks in the supply chain been widely recognised.

6.3 Research Question 2

> **RQ2.** How can DSS used by intermediary, commodity trading companies help them make decisions that are pivotal to their performance and the performance of the supply chain?

As explained theoretically and confirmed empirically, intermediary trading organisations play an important role in the upstream commodity supply chains in assisting the movement of goods from the countries of production to the countries of manufacturing. The organisations are faced with several sets of decisions such as: commodity origin location, quality or grades of commodity and schedule for shipment which in combination distinguish the price of goods. These decisions are critical to the success of intermediary trading operations to ensure reduction/minimisation of transaction costs (Beck, 2007; Quark, 2011). Considering supply chain complexity and the long-term nature of the contracts, these decisions affect the overall company performance and stakeholders' perceptions of the impact and role of intermediary organisations in the supply chains. The processes behind the decisions by intermediary traders is not always clear or purely rational. The trading company considers numerous environmental factors such as weather conditions, the political or economic situation and market price levels when making those decisions, but nowadays, in the settings of greater supply chain visibility, those decisions need to be perceived as transparent and rational by different groups of stakeholders. In their operations, intermediary companies have to balance trade-offs cost vs lead time, cost vs quality etc. in order to remain profitable (Sandberg, 2017). The case studies agreed that the system allows them to have a better view of their operations in order to make those trade-off decisions.

Decision-making is a core capability of an intermediary trading company, but due to structural inefficiencies in all three cases, it has been found that some tasks have been replicated and could lead to errors and conflicting decisions made. The lack of process ownership and clear structure of the operations have been found in all three case studies. Moreover, the lack of unified documentation/reports, evidence of amendments and changes, and lack of readily available historic data have been found from the cross case analysis. DSS enabled companies

to define the processes and streamline the tasks. Accurate and timely reporting, audit history and overtime trend analysis are used in daily operations for decision-making.

Supply chain capabilities refer to the ability of an organisation to identify, utilize, and assimilate both internal and external resources and information to assist the entire supply chain activities (Wu et al., 2006; Tseng et al., 2011). DSS plays an important role in firms' performance by providing information flow to make the supply chain more robust and resilient without undermining efficiency (Phillips-Wren et al., 2011; Tseng et al., 2011). In this research, the participants agreed with the supply chain capabilities improved by promoting connectivity, controls and visibility within the company and among supply chain partners. The increase of exchange of information between stakeholders in the supply chain built overtime through improved communication and trust and allows to realize better supply chain performance (Jean et al., 2008; Sinkovics and Kim 2014; Busse, 2016).

The supply chain performance have been defined in conceptual model as combination of financial performance (creditworthiness and cashflow), operational efficiency (ability to effectively manage physical flow of goods) and relational performance (communication, trust and supplier involvement). It was demonstrated that the improved decision making by intermediary trading company as a coordinator in the supply chains, will drive the improved supply chain performance. It was therefore established that the change in information management systems by means of DSS influence company performance and provide mediating effects on supply chain performance.

6.4 Summary

In this thesis, it is argued and demonstrated that adopting DSS can improve intermediary organisations' performance by enhanced decision making and visibility; and supply chain performance by better management of the supply chain challenges identified.

7 Chapter 7 Conclusions

The conclusion of this thesis provides a summary of all aspects of the research conducted. The overall picture regarding the operations of the intermediary trading companies in the upstream supply chains is summarised. The DSS which are used by intermediary trading organisations were explored through multiple case studies. The DSS have been described as a means of achieving greater operational visibility and improved decision making leading to improved performance in upstream commodity supply chains. The theoretical lens of the relational view provided guidance to data collection and analysis. The findings of the study were triangulated with literature to draw conclusions and situate the study in a general context. This chapter outlines the research contributions to knowledge, the body of literature and commodity supply chain policy. The research limitations are acknowledged and recommendations for future studies is also discussed.

7.1 Summary of Research

This research attempts to understand how DSS in upstream commodity supply chains can help manage the challenges introduced by the dynamic and volatile environment of the commodity trade and provide improved business and supply chain performance through enhanced decision-making and improved operational visibility. A qualitative case study method was conducted in order to gain a first-hand view and insight into the experience of respondents with respect to the DSS. A multiple case study approach enabled the researcher to review the phenomenon under investigation among intermediary organisations of different size and commodities traded in upstream supply chains. The theoretical lens of relational view was adopted and offered guidance to data collection and analysis. The literature review in this research covered issues pertaining to upstream supply chain challenges, intermediation and trade of commodities, DSS in the supply chains and performance measurement and assessment approaches. Theoretical literature of operations management theories including a relational view are also presented. A conceptual framework developed based on the literature reviewed and is used as a guide to the research process. The specific concepts used in the conceptual model included the Supply Chain Governance model by Dolci and Macada (2014), empirical variables of challenges in trade finance in developing countries by Auboin (2016); risk management classifications taken from Rao and Goldsby (2009) in combination with Cinar et al., (2016); operational efficiency and performance factors adopted from Aramyan et al. (2006).

The data was collected from three case studies – a rubber trading company, a coffee trading company, and a cotton merchant. Two case studies were longitudinal in nature and were undertaken over an extended period of time, specifically, interviews conducted at the start of the implementation process for the DSS, on-site observations undertaken during the implementation process, and another series of semi-structured interviews conducted after the completion of the implementation process. Case Study 3 reviewed the processes and operational changes retrospectively. Additional sources of evidence included secondary data analysis from documents and market reports and interviews with the field experts. The interview guide was used to collect comprehensive data during semi-structured interviews. Moreover, the research strategy included process mapping for 'before' and 'after' DSS implementation of the operations and business flow in intermediary trading companies. The

process maps allowed to show internal company processes and interactions with supply chain stakeholders. The data was rigorously analysed and linked with the evidence from the literature. A cross-case analysis was undertaken to aggregate common themes and patterns among intermediary trading companies.

The data analysis revealed and proved that the decision support and access to accurate information are key to drivers of the intermediary performance. The decisions are made in a dynamic environment for long-term future contracts. In the environment of high uncertainty and market volatility, access to the most accurate and up-to-date information is crucial. Thus, intermediary companies implement DSS for operations management and control.

7.2 Research Questions

In this section, the overarching research questions will be briefly and concisely addressed to summarise the main findings and discussions.

7.2.1 Research Question One

> **RQ1:** What are the core, performance influencing challenges of upstream commodity supply chains and how can these challenges be addressed or exacerbated by the actions of intermediary traders?

It was discovered that the core challenges relating to upstream supply chain performance are associated with the supply chain governance, access to finance by the supply chain participants to fund import/export operations, risk management in the environment of high uncertainty. Lastly, operational efficiencies been recognised as a challenge due to long lead times for production, global deliveries and storage capacities. Misalignment between the objectives of the retailers who prefer late ordering in order to avoid demand uncertainty and inventory speculation; suppliers prefer longer lead times to better optimise and manage their production capacities (Sandberg, 2017) represent another challenge for the supply chain. The lack of partnerships and centralisation between supply chain stakeholders leading to information asymmetry, preventing transparency and optimisation of processes hence directly negatively impacting cycle time performance. The intermediary trading organisation

are adding value to the upstream supply chains by addressing and managing those challenges. Intermediaries are using their extensive knowledge about the field, extensive risk management policies and developing relationships with supply chain partners. Successful operations of the intermediary trading companies are supposed to reflect in the reduction of transaction costs for the customers. The factors for intermediary high performance are relying on their decision-making. The understanding of the full business process and intermediary operations have been gained.

7.2.2 Research Question Two

> **RQ2:** How can information systems used by intermediary, commodity trading companies help them make decisions that are pivotal to their performance and the performance of the supply chain?

The benefits of using DSS in dynamic environments with lack of visibility and high-pace decision-making are enhanced information flows and improved collaboration that help companies adopt to changing environments (El Sawy & Pavlou, 2008 in Zhang et al., 2013). It was demonstrated that intermediary decision-making play critical role in the company operations and have an impact on the supply chain performance. The information easily accessible by means of DSS and allow better-informed and quick decisions to be made (Caridi, et al., 2014).

It was demonstrated that new information systems improve the transparency of decision-making relating to judgements to buy or sell commodities, make a hedge transaction, supplier selection and others; as well as enhancing capabilities for corporate and supply chain governance compliance. Moreover, new risk management reporting and operational visibility has enabled decision makers to further develop (re-assess) company risk management policies and company strategies, enhancing consistency and robustness of the performance analysis by having in place structured operational framework through defined workflows.

It was found that the role of DSS in supply chain performance reflected in improved information flows, stakeholder coordination and communication, and business creditworthiness. In this research, the participants agreed that the supply chain capabilities

improved by promoting connectivity, controls and visibility among supply chain partners to drive effective management of physical across the supply chain, increase of trade volumes and stakeholder coordination.

7.3 Contributions of Study

The fundamental contribution of this research is to extend prior research in the intermediary trade in operations management.

7.3.1 Contribution to Knowledge and Body of Literature

This study makes several contributions to academic literature. Outputs from this study are a response to the call for research in commodity trade intermediation (Fung et al., 2010, Adebanjo, 2009; Arya et al., 2015) in order to add to the body of knowledge. Although supply chain management research is growing in scope and becoming more theoretically developed, a systematic understanding of how DSS contributes to the intermediary company and supply chain performance was lacking (Arora et al., 2013). This research makes several contributions to SCM literature and managerial practice. Primarily, by developing a relational view of the impact of DSS on organisation performance, we extend conceptualisation of SCM and expand the research to new theoretical approaches and conceptual frameworks in SCM (Manuj and Mentzer, 2008; Chen and Paulraj, 2004; Du Toit and Vlok, 2014). Secondly, the influence of relationships on supply chain performance is highlighted, addressing the need to investigate the dynamics of buyer-supplier relationships for supply chain collaboration and integration (Fung, 2007; Arora et al., 2013). Additionally, an upstream supply chain performance view contributes to the growing body of knowledge on responsible sourcing and understanding of the initial stages of the supply chain of primary commodities.

7.3.2 Contributions to Practice

The results of this study offer a new contribution to practice through providing a suggested key factors that impact supply chain performance that can be used when adopting a new DSS. The architecture of the DSS reviewed can help practitioners to better understand and attempt to quantify the impact of DSS on the company operations. Moreover, DSS designated for intermediary commodity trade that specifically addresses operational needs such as position reporting, scheduling, M2M and exposure should contribute to the understanding of those systems.

7.4 Limitations of Research

Firstly, the findings have been developed based on the perceptions, views and experience of intermediary trading companies' participants. The supply chain maps have been developed based on their opinion and understanding. The results presented here have the limitations of examining only the view of the intermediary and intermediary service providers. The suppliers and customers of the intermediary organisations have not been recruited to review any changes. However, the limitations were overcome to a certain extent by the extensive literature review, on-site observations and additional interviews with field experts.

Secondly, this study has not considered the change management process of the DSS transformations within the company. The implementation project success factors and requirements were not taken into account either. The user perceptions and impact on their day-to-day work were acknowledged.

Moreover, the aspect of cultural differences in cross-border trade or international operations were discounted. The features of the upstream supply chain trading context have been extensively reviewed in the literature and considered sufficient for the purpose of this research.

7.5 Recommendations for Future Research

In addition to this research about the impact of DSS on the intermediary trading organisations' performance, a number of issues can be further addressed. The findings in this study can serve as a starting point for future research to further explore a range of different commodity supply chains – sugar, cocoa, soy beans, metals and energy sectors. Other future research directions include:

- Potential of role of cultural differences on the intermediary operations and DSS requirements and impact on performance
- Application of integrated DSS across the supply chain participants and intermediaries as a supply chain coordinator
- Test the impact of DSS on intermediary social responsibility and drive for sustainability for both suppliers and customers
- Potential to develop measures and methods to compare different DSS designs for intermediary commodity trading operations
- There is a need to investigate security concerns of the DSS in regards to storing and sharing sensitive data, transactional data, integration with new technologies such as blockchain or internet of things sensors
- Achieving greater understanding of the behavioural operations approach that is growing in operations management research (Gino and Pisano, 2008). Future attempts can be made to review the intermediary trading operations and decision support based on the behavioural aspects of the trade professionals
- Investigation into the inclusion of relational and cognitive factors such as shared values and personal relationships when reviewing impact of DSS of upstream and downstream supply chain networks
- Finally, the work can be undertaken to link the performance of the upstream supply chains to the downstream parts of the supply chains. The intermediary trading operations provide a link between primary commodity producing regions and

manufacturing countries, but the impact of their operations on the downstream supply chains and distribution is not well understood.

7.6 Summary

In this section, a summary of this case study research and key findings are provided. The multiple case study methodology applied to answer the research questions. The contributions from this research made to the body of knowledge of intermediation in the operations management literature. Also, the results can be applied to various participants within the upstream supply chains and provide a basis for the programmes and projects in upstream supply chains management and traceability systems. It is argued that there was no specific study to address the impact of the DSS at intermediaries in the upstream supply chain, and therefore this study can be considered as a contribution to the scholarly knowledge in this area. The limitations of this study such as change management process review and discounted cultural differences between partners in the supply chain were acknowledged. Finally, recommendations were made for future studies into integrated DSS among supply chain participants in the upstream supply chains and others. The finding of this study can also provide insight into traceability systems to support global sustainability initiatives.

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Appendixes

Appendix 1 Tradable commodities on exchange markets (Full)

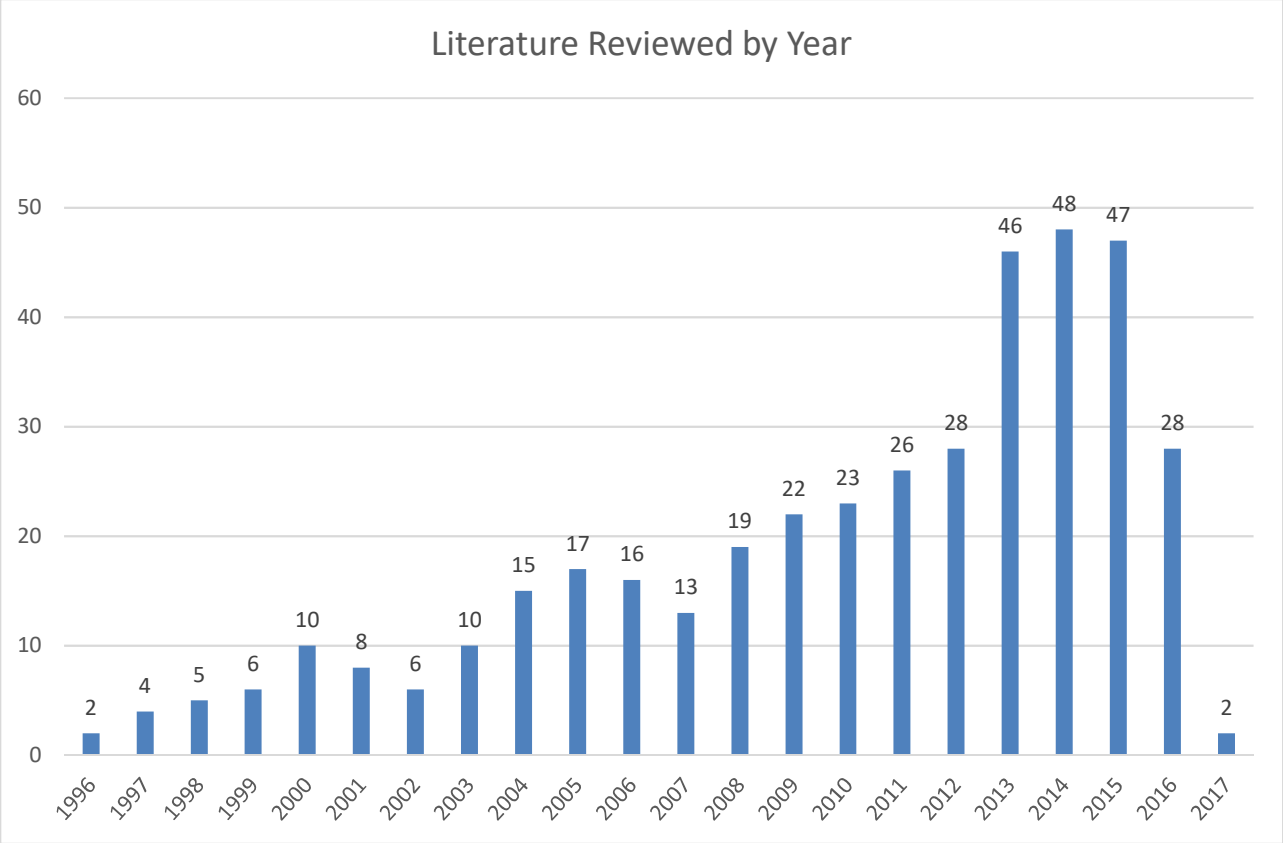
COMMODITIES	GROUP	MAIN EXCHANGE	CURRENCY
CORN	Agriculture	CBOT/Euronext	USD ($)
OATS	Agriculture	CBOT	USD ($)
RICE	Agriculture	CBOT	USD ($)
SOYBEANS	Agriculture	CBOT	USD ($)
SOYBEANS OIL	Agriculture	CBOT	USD ($)
SOYBEANS MEAL	Agriculture	CBOT	USD ($)
WHEAT	Agriculture	CBOT	USD ($)
PALM OIL	Agriculture	Bursa Malasia	Malasian Ringgit (RM)
COCOA	Soft	ICE	USD ($)
COFFEE	Soft	ICE	USD ($)
COTTON	Soft	ICE	USD ($)
SUGAR	Soft	ICE	USD ($)
ORANGE	Agriculture	ICE	USD ($)
ORANGE JUICE CONCENTRATE	Agriculture	ICE	USD ($)
LIVE CATTLE	Agriculture	Chicago Mercantile Exchange	USD ($)
FEEDER CATTLE	Agriculture	Chicago Mercantile Exchange	USD ($)
LEAN HOGS	Agriculture	Chicago Mercantile Exchange	USD ($)
MILK	Agriculture	Chicago Mercantile Exchange	USD ($)
TIMBER	Agriculture		
RUBBER	Agriculture	Singapore Commodity Exchange	US cents
CRUDE OIL	Energy	NYMEX, ICE£	USD ($), GBP (£)
GASOLINE	Energy	NYMEX	USD ($)
ETHANOL	Energy	CBOT	USD ($)
HEATING OIL	Energy	NYMEX	USD ($)
NATURAL GAS	Energy	NYMEX	USD ($)
PROPANE	Energy	NYMEX	USD ($)
GOLD	Metal	COMEX	USD ($)

PLATINUM	Metal	COMEX	USD ($)
PALLADIUM	Metal	COMEX	USD ($)
SILVER	Metal	COMEX	USD ($)
COPPER	Metal	London Metal Exchange, New York Exchange	USD ($)
LEAD	Metal	London Metal Exchange	USD ($)
ZINC	Metal	London Metal Exchange	USD ($)
TIN	Metal	London Metal Exchange	USD ($)
ALUMINIUM	Metal	London Metal Exchange, New York Exchange	USD ($)
COBALT	Metal	London Metal Exchange	USD ($)
NICKEL	Metal	London Metal Exchange	USD ($)
STEEL	Metal	Rotterdam	USD ($)
RECYCLED STEEL	Metal	Rotterdam	USD ($)
MOLYBDENUM	Metal	London Metal Exchange	USD ($)

Appendix 2 Literature Review Sources (resources with over 3 papers used)

ACADEMIC JOURNAL	COUNT
ACADEMY OF MANAGEMENT REVIEW	5
AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS	4
APPLIED ECONOMICS	3
DECISION SCIENCES	3
DECISION SUPPORT SYSTEMS	13
EUROPEAN JOURNAL OF OPERATIONAL RESEARCH	6
INDUSTRIAL MANAGEMENT AND DATA SYSTEMS	3
INFORMATION SYSTEMS JOURNAL	3
INTERNATIONAL JOURNAL OF LOGISTICS MANAGEMENT	3
INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS	11
INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH	9
INTERNATIONAL JOURNAL OF PRODUCTIVITY AND PERFORMANCE MANAGEMENT	4
INTERNATIONAL JOURNAL OF SUPPLY CHAIN MANAGEMENT	3
INTERNATIONAL MARKETING REVIEW	3
JOURNAL OF FASHION MARKETING AND MANAGEMENT	3
JOURNAL OF INTERNATIONAL BUSINESS STUDIES	3
JOURNAL OF INTERNATIONAL ECONOMICS	4
JOURNAL OF INTERNATIONAL TRADE AND ECONOMIC DEVELOPMENT	7
JOURNAL OF MANAGEMENT INFORMATION SYSTEMS	3
JOURNAL OF OPERATIONS MANAGEMENT	16
MANAGEMENT SCIENCE	4
MANUFACTURING AND SERVICE OPERATIONS MANAGEMENT	5
MIS QUARTERLY	5
PRODUCTION AND OPERATIONS MANAGEMENT	5
PRODUCTION PLANNING AND CONTROL	3
SSRN ELECTRONIC JOURNAL	5
SUPPLY CHAIN MANAGEMENT: AN INTERNATIONAL JOURNAL	8
WORLD DEVELOPMENT	3
WORLD ECONOMY	3

Appendix 3 Literature Reviewed by Year



Appendix 4 Interviews coding (full)

CASE STUDY	INTERVIEWEES POSITION	ID	INTERVIEW	TIME (HRS)
CASE STUDY 1	Finance director	CS1I1	1	1
	Project manager	CS1I2 CS1I3 CS1I4	3	3.5
	Senior Trader (natural rubber)	CS1I5	1	1
	Senior trader and FX	CS1I6		
	Operations manager	CS1I7		
	Logistics manager	CS1I8 CS1I9		
	Logistics manager (Liquid commodities)	CS1I10 CS1I11		
	Director	CS1I12		
	Contracts Administrator	CS1I13		
CASE STUDY 2	CEO	CS2I1 CS2I2	2	1
	Senior traders	CS2I3 CS2I4	2	2
	Project Manager	CS2I5 CS2I6	2	
	Logistics/Operations manager	CS2I7 CS2I8	2	3
	Finance	CS2I9 CS2I10	2	1
CASE STUDY 3	MD/Senior trader	CS3I1 CS3I2 CS3I3	3	7
PARTICIPANT 1	CEO, former trader, consultant cotton	P1	1	1
PARTICIPANT 2	Insurance Company	P2 and P3	2	1
PARTICIPANT 3	Supply chain consultant/advisory	P4	1	1
PARTICIPANT 4	Senior Business Analyst/consultant	P5	1	2
PARTICIPANT 5	CEO	P6	3	4
	Senior solutions architect	P7	1	1

Appendix 5 Interview Question Protocols CS1 and CS2

CS1 and CS2 Interview question protocol – Before – Trade department

NO	INTERVIEW QUESTION	COMMENT
INFORMATION ABOUT THE COMPANY AND THEIR SUPPLY CHAIN		
1.	Could you please give me an introduction to the main company activities?	
2.	What are the specificities of the sector you are in?	
3.	How does the company add value to the supply chain?	
4.	What do you see as the challenges of the supply chain that might make you change anything in the way you operate?	
5.	How did supply chain change over the last decade? What do you expect to happen in the next decade?	
6.	What are the main controls do you have in place to manage those risks?	
7.	What are your main activities as trader, tasks? What tools you are using and they affect other people in your organisation?	
8.	How do you characterise your relationship with the other participants in the supply chain?	
9.	What is the governance structure of your supply chain? What the sustainability requirements/issues in your supply chain?	
10.	What are the key performance indicators for your business? And how do you track them?	

CS1 and CS2 Interview question protocol – After – Trade department

NO	INTERVIEW QUESTION	COMMENT
INFORMATION ABOUT THE CHNAGES INTRODUCED BY DSS AND COMPANY PERFORMANCE		
11.	What were the main drivers for implementing a new system? What was the critical functionality for your department?	
12.	In your opinion, how did DSS impact on your business visibility and transparency?	
13.	Did the tasks you execute change? How?	

14.	Did DSS improve operational efficiencies? How?	
15.	How was the system aligned with your company business processes?	
16.	Did your risk management approach had to change?	
17.	Did it improve your decision making? What department it had most impact on?	
18.	Did you notice any changes in the company performance since you implemented the new system? Did you change the ways you measure your performance?	
19.	In your opinion, did DSS help improve communication within the company?	
20.	What would you add to/change in your DSS?	
21.	Describe your relationship with various supply chain partners. How important is trust in current state of the supply chain? Did it have any impact of the choice/way the new DSS was implemented? Did DSS impact on your relationships with the banks?	
22.	How did the new system impact your relationship with supply chain partners?	
23.	What is supply chain governance structure (power allocated) in your supply chain and how much it affects the way you work with your counterparts?	
24.	Did the system help improve communication with your partners? How?	
25.	How do you think it helped reduce supply risk for your counterparties?	
26.	Do DSS help you streamline some operations with your counterparties?	
27.	Did the system help you monitor your performance in a different way? Gave you more insights into the business?	

CS1 and CS2 Interview question protocol – Before – Logistics department

NO	INTERVIEW QUESTION	COMMENT
INFORMATION ABOUT THE COMPANY AND THEIR SUPPLY CHAIN		
1.	Could you please give me an introduction to the main company activities?	

2.	What are the specificities of the sector you are in?	
3.	How does the company add value to the supply chain?	
4.	What do you see as the challenges of the supply chain that might make you change anything in the way you operate?	
5.	How did supply chain change over the last decade? What do you expect to happen in the next decade?	
6.	What are the difficulties you overcome day-to-day? What are the main controls do you have in place to manage the risks of goods in transit or storage?	
7.	What are your main activities in logistics department, tasks? What tools you are using and they affect other people in your organisation?	
8.	How do you characterise your relationship with the other participants in the supply chain? Who do you work most closely with?	
9.	What is the governance structure of your supply chain? What the sustainability requirements/issues in your supply chain?	
10.	What are the key performance indicators for your department? And how do you track them?	

CS1 and CS2 Interview question protocol – After – Logistics department

NO	INTERVIEW QUESTION	COMMENT
INFORMATION ABOUT THE CHNAGES INTRODUCED BY DSS AND COMPANY PERFORMANCE		
11.	What were the main drivers for implementing a new system? What was the critical functionality for your department?	
12.	In your opinion, how did DSS impact on your visibility within your department, business and supply chain overall?	
13.	Did the tasks you execute change? How?	
14.	Did DSS improve operational efficiencies? How? Did you achieve any reduction in time spent on tasks, reduction of business trade cycle or help you find most efficient routes of transportation?	
15.	How was the system aligned with your company business processes?	
16.	Did your risk management approach had to change?	

17.	How did the system help in your decision making? What task it had most impact on?	
18.	Did you notice any changes in the company performance since you implemented the new system? Did you change the ways you measure your performance?	
19.	In your opinion, did DSS help improve communication within the company?	
20.	What would you add to/change in your DSS?	
21.	Describe your relationship with various supply chain partners. How important is trust in current state of the supply chain? Did it have any impact of the choice/way the new DSS was implemented?	
22.	How did the new system impact your relationship with supply chain partners (shipping lines, inspection companies)?	
23.	What is supply chain governance structure (power allocated) in your supply chain and how much it affects the way you work with your counterparts?	
24.	Did the system help improve communication with your partners? How?	
25.	How do you think it helped reduce supply risk for your counterparties?	
26.	Do DSS help you streamline some operations with your counterparties?	
27.	Did the system help you monitor your performance in a different way? Gave you more insights into the business?	

CS1 and CS2 Interview question protocol – Before – Finance department

NO	INTERVIEW QUESTION	COMMENT
INFORMATION ABOUT THE COMPANY AND THEIR SUPPLY CHAIN		
1.	Could you please give me an introduction to the main company activities?	
2.	What are the specificities of the sector you are in?	
3.	How does the company add value to the supply chain?	
4.	What do you see as the challenges of the supply chain that might make you change anything in the way you operate?	

5.	How did supply chain change over the last decade? What do you expect to happen in the next decade?	
6.	What are the difficulties you overcome day-to-day? What are the main controls do you have in place to manage the risks of goods in transit or storage?	
7.	What are your main activities in accounting and finance department, tasks? What tools you are using and they affect other people in your organisation?	
8.	How do you characterise your relationship with the other participants in the supply chain? Who do you work most closely with? How do you manage your relationships with banks? What is the process of opening credit lines?	
9.	What is the governance structure of your supply chain? What the sustainability requirements/issues in your supply chain?	
10.	What are the key performance indicators for your department? And how do you track them?	

CS1 and CS2 Interview question protocol – After – Finance department

NO	INTERVIEW QUESTION	COMMENT
INFORMATION ABOUT THE CHNAGES INTRODUCED BY DSS AND COMPANY PERFORMANCE		
11.	What were the main drivers for implementing a new system? What was the critical functionality for your department?	
12.	In your opinion, how did DSS impact on your visibility within your department, business and supply chain overall? How did it improve reporting?	
13.	Did the tasks you execute change? How?	
14.	Did DSS improve operational efficiencies? How? Did it improve accuracy of data and reporting?	
15.	How was the system aligned with your company business processes?	
16.	Did your risk management approach had to change?	
17.	How did the system help in your decision making? What task it had most impact on?	
18.	Did you notice any changes in the company performance since you implemented the new system?	

	Did you change the ways you measure your performance?	
19.	In your opinion, did DSS help improve communication within the company?	
20.	What would you add to/change in your DSS?	
21.	Describe your relationship with various supply chain partners. How important is trust in current state of the supply chain? Did it have any impact of the choice/way the new DSS was implemented? Did DSS impact on your relationships with the banks?	
22.	How did the new system impact your relationship with supply chain partners?	
23.	What is supply chain governance structure (power allocated) in your supply chain and how much it affects the way you work with your counterparts?	
24.	Did the system help improve communication with your partners? How?	
25.	How do you think it helped reduce supply risk for your counterparties?	
26.	Do DSS help you streamline some operations with your counterparties?	
27.	Did the system help you monitor your performance in a different way? Gave you more insights into the business?	

Appendix 6 Interview Questions Protocol CS3

CS3I1 – Information about the company

NO	INTERVIEW QUESTION	COMMENT
1.	Could you please give me an introduction to the main company activities?	
2.	What are the specificities of the cotton trade?	
3.	How does the company add value to the supply chain?	
4.	What do you see as the challenges of the supply chain that might make you change anything in the way your company operates?	
5.	What do you consider the risks for cotton trading nowadays? How did they change over the last decade? What do you expect to happen in the next decade?	

6.	What are the main controls do you have in place to manage the risks?	
7.	What are your main activities, tasks? What tools you are using and they affect other people in your organisation?	
8.	How do you characterise your relationship with the other participants in the cotton supply chain?	
9.	What the sustainability requirements/issues in cotton supply chain?	
10.	What are the key performance indicators for your business? And how do you track them?	

CS3I2 – DSS used by trading company and implementation process

NO	INTERVIEW QUESTION	COMMENT
11.	What were the main drivers for implementing a new system? What was the critical functionality for your business?	
12.	In your opinion, how did DSS impact on your business visibility and transparency?	
13.	Did the tasks you execute change? How?	
14.	Did DSS improve operational efficiencies? How?	
15.	How was the system aligned with your company business processes?	
16.	Did your risk management approach had to change?	
17.	Did it improve your decision making? What department it had most impact on?	
18.	Did you notice any changes in the company performance since you implemented the new system?	
19.	In your opinion, did DSS help improve communication within the company?	
20.	What would you add to/change in your DSS?	

CS3I3 – Changes in supply chain performance

NO	INTERVIEW QUESTION	COMMENT
21.	Describe your relationship with various supply chain partners. How important is trust in current state of the supply chain? Did it have any impact of the choice/way the new DSS was	

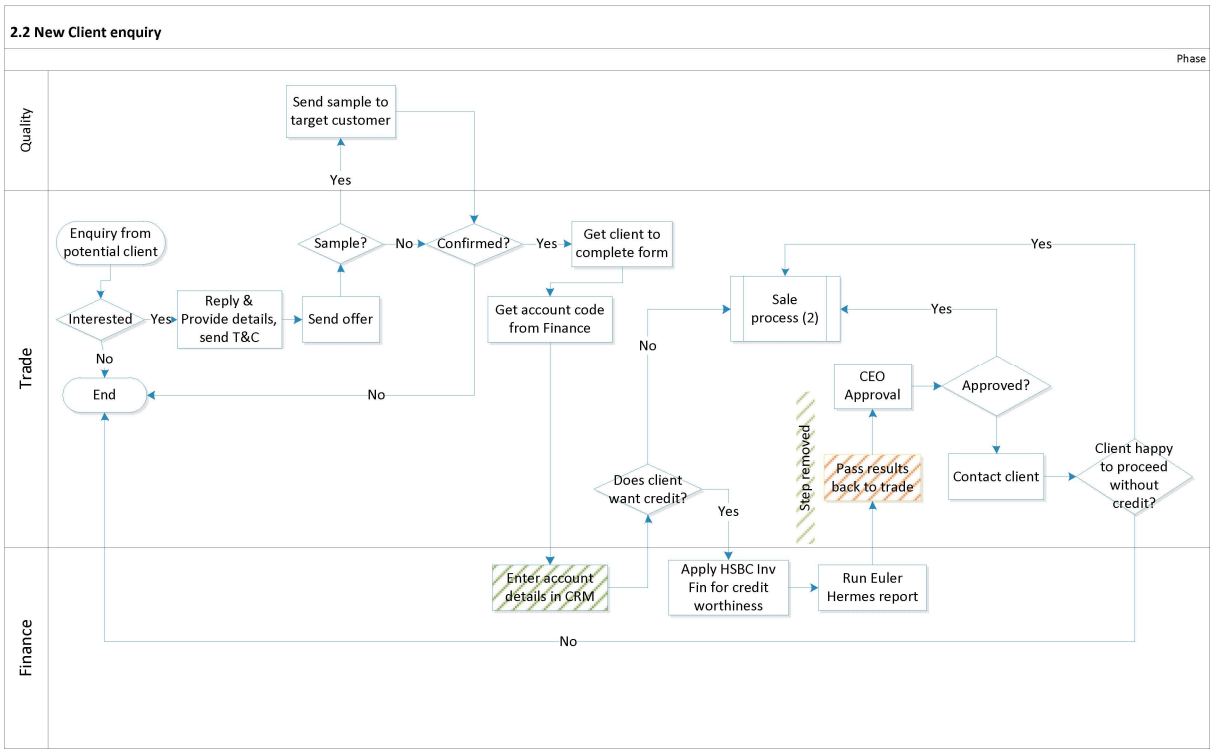
	implemented? Did DSS impact on your relationships with the banks?	
22.	How did the new system impact your relationship with supply chain partners?	
23.	What is supply chain governance structure (power allocated) in your supply chain and how much it affects the way you work with your counterparts?	
24.	Did the system help improve communication with your partners? How?	
25.	How do you think it helped reduce supply risk for your counterparties?	
26.	Do DSS help you streamline some operations with your counterparties?	
27.	Did the system help you monitor your performance in a different way? Gave you more insights into the business?	

Appendix 7 Interview Questions Protocol Field Experts

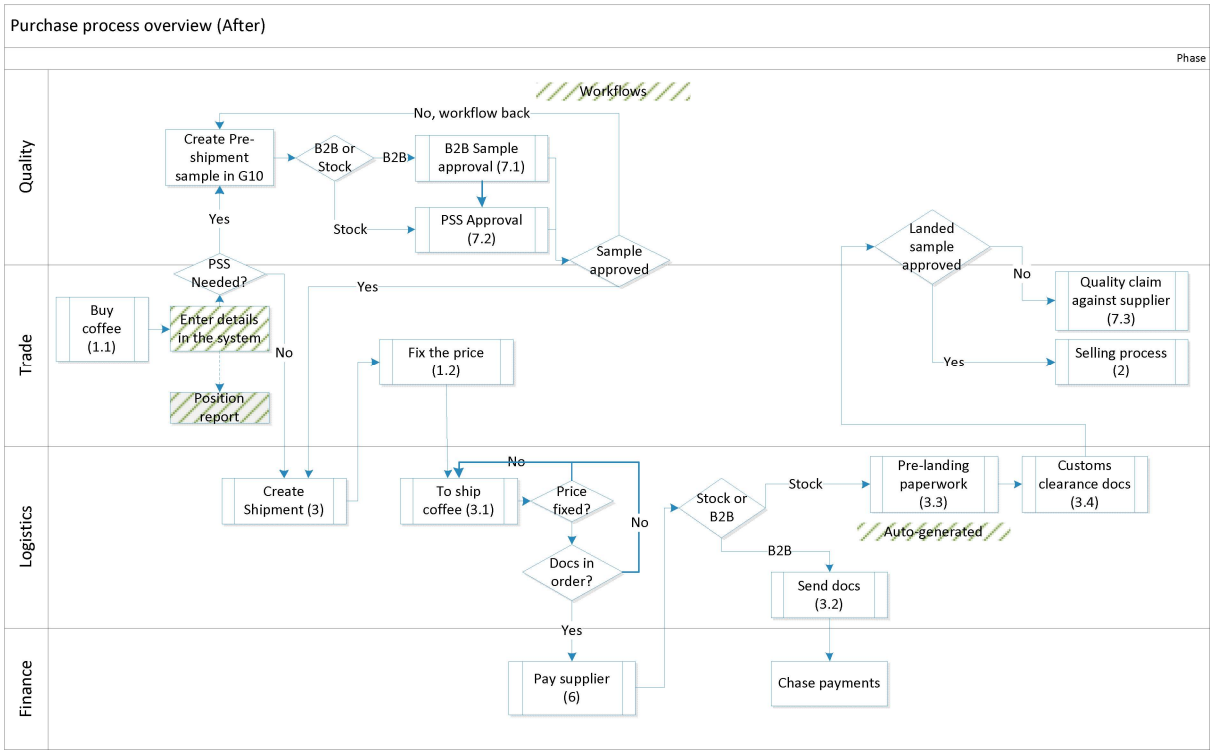
NO	INTERVIEW QUESTION	COMMENT
1.	What are the specificities of the sector you are in?	
2.	Where is the most value created in the supply chain?	
3.	What do you see as the challenges of the supply chain that might make companies change anything in the way they operate?	
4.	How important is the issue of access to finance in commodity supply chains?	
5.	How did supply chain change over the last decade? What do you expect to happen in the next decade?	
6.	What are the main controls that companies apply to manage the risks of goods in transit or storage?	
7.	What is the governance structure of the supply chain? Who has the most power in the supply chain? What the sustainability requirements/issues in your supply chain?	
8.	What do you think are the key performance indicators for the supply chain? And how they should be tracked?	
9.	What in-efficiencies do you observe in the supply chains and how they can be improved?	

10.	What systems are used in supply chain that you know about? How do systems help in decision making?
11.	Describe the type of relationships among various supply chain partners. How important is trust in current state of the supply chain? Would DSS have an impact on relationships within supply chains?
12.	In your opinion, how DSS can help improve company and supply chain performance?

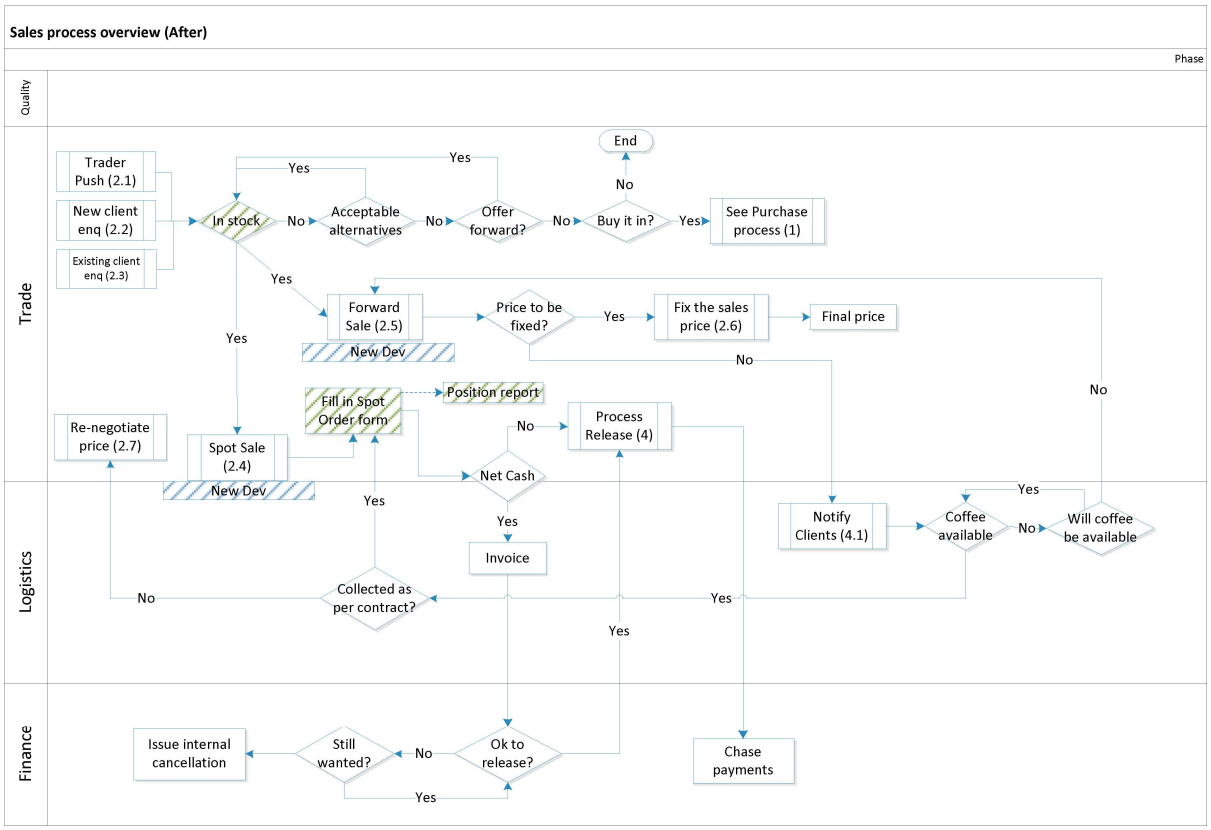
Appendix 8 New Customer Enquiry CS2 'After'



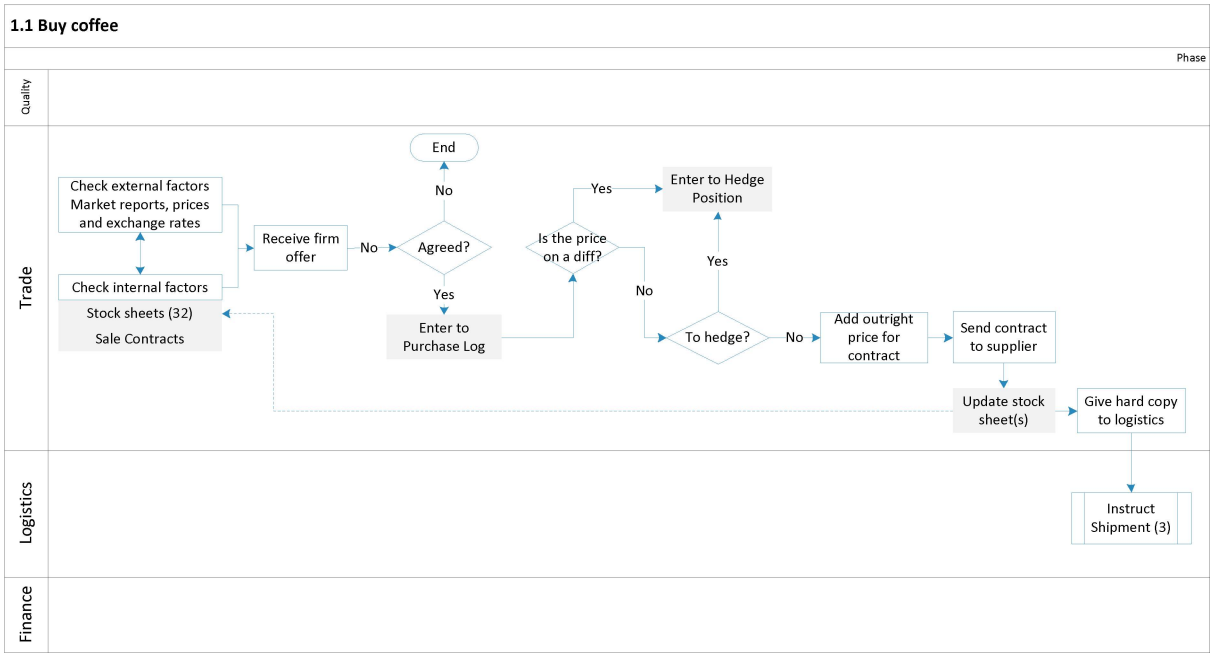
Appendix 9 Purchase process overview CS2 'After'



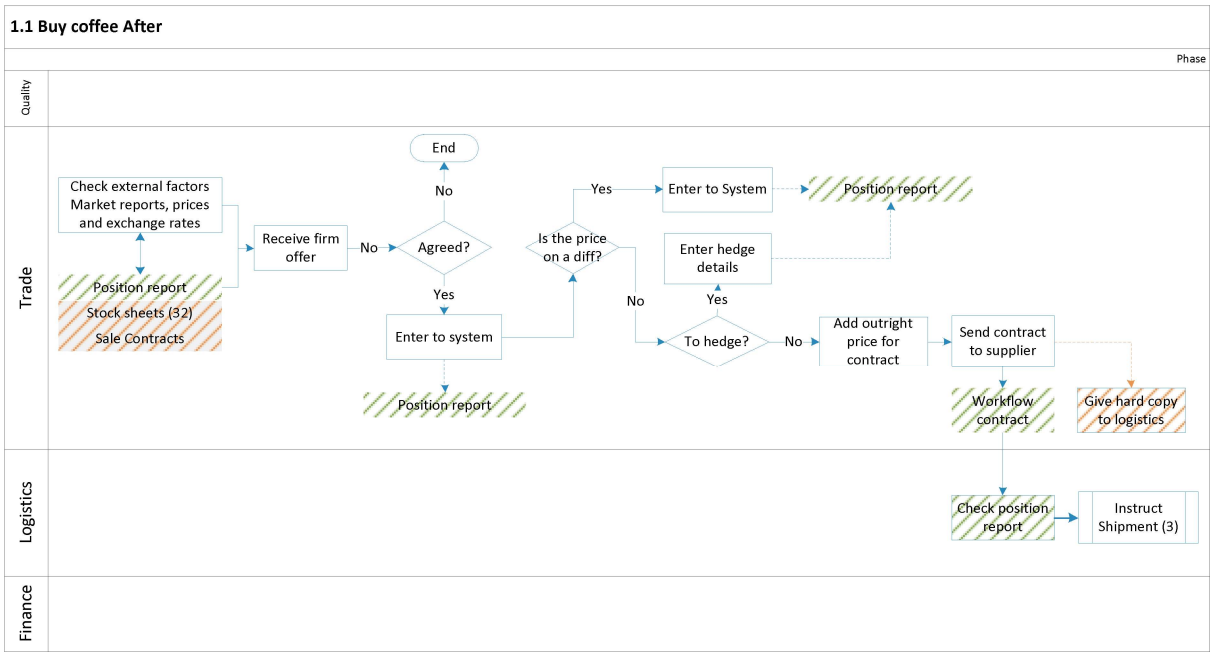
Appendix 10 Sale process overview CS2 'After'



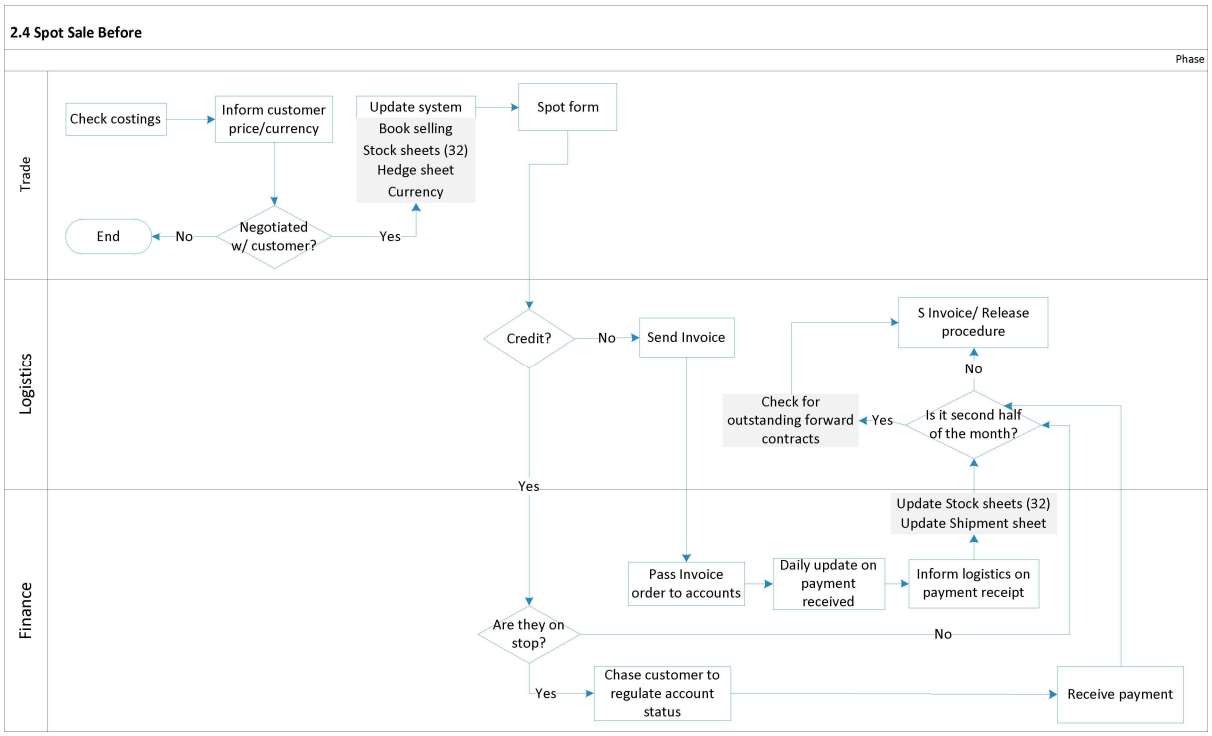
Appendix 11 Buy Coffee CS2 'Before'



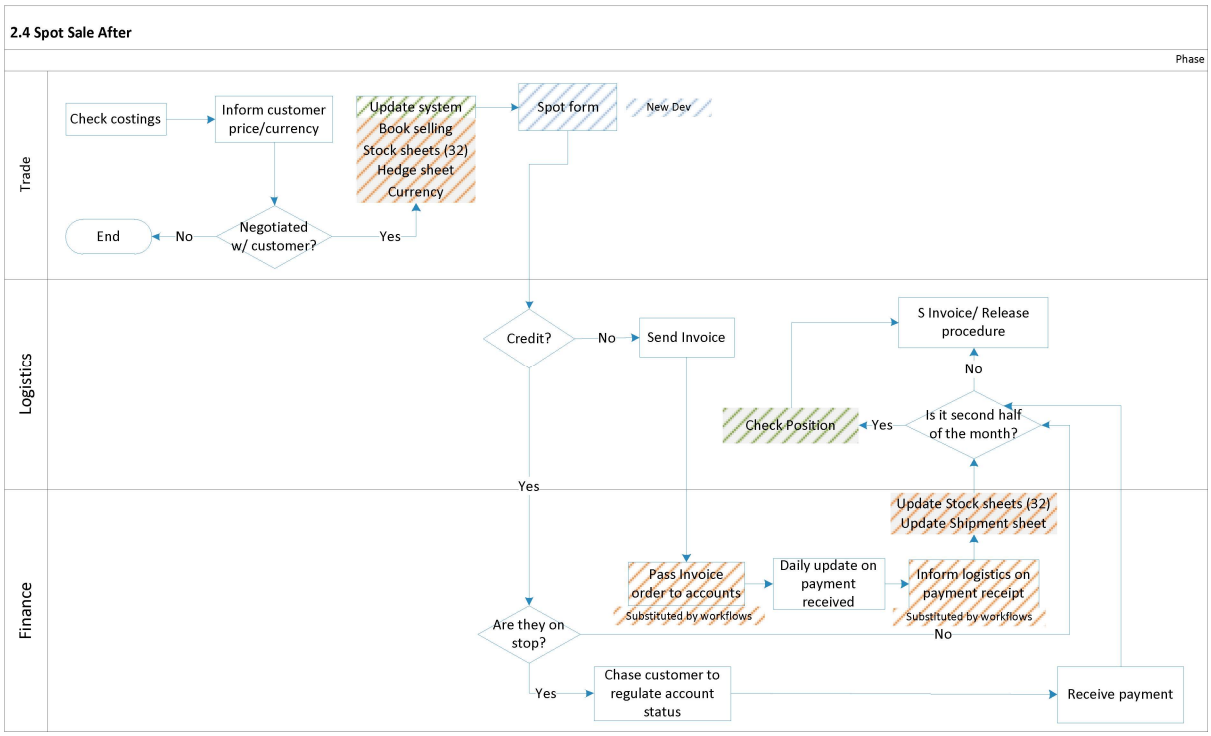
Appendix 12 CS2 Buy Coffee CS2 'After'



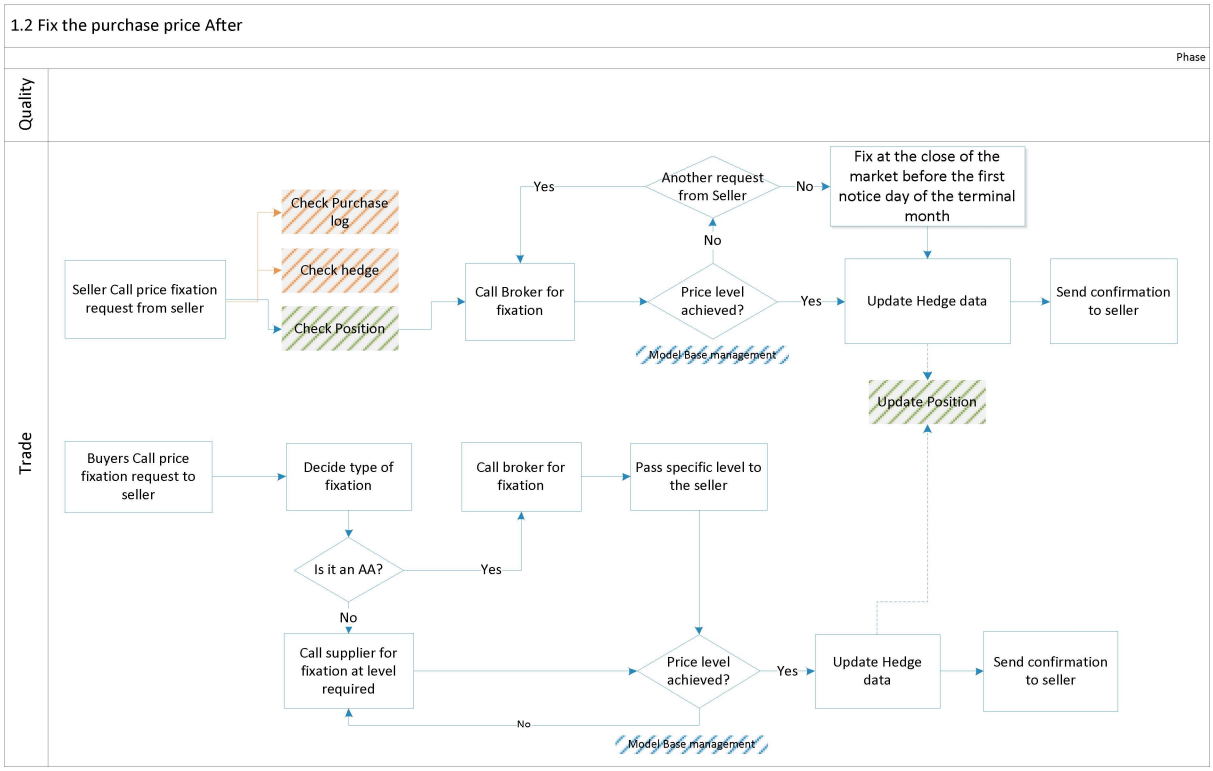
Appendix 13 'Spot Sale' CS2 'Before'



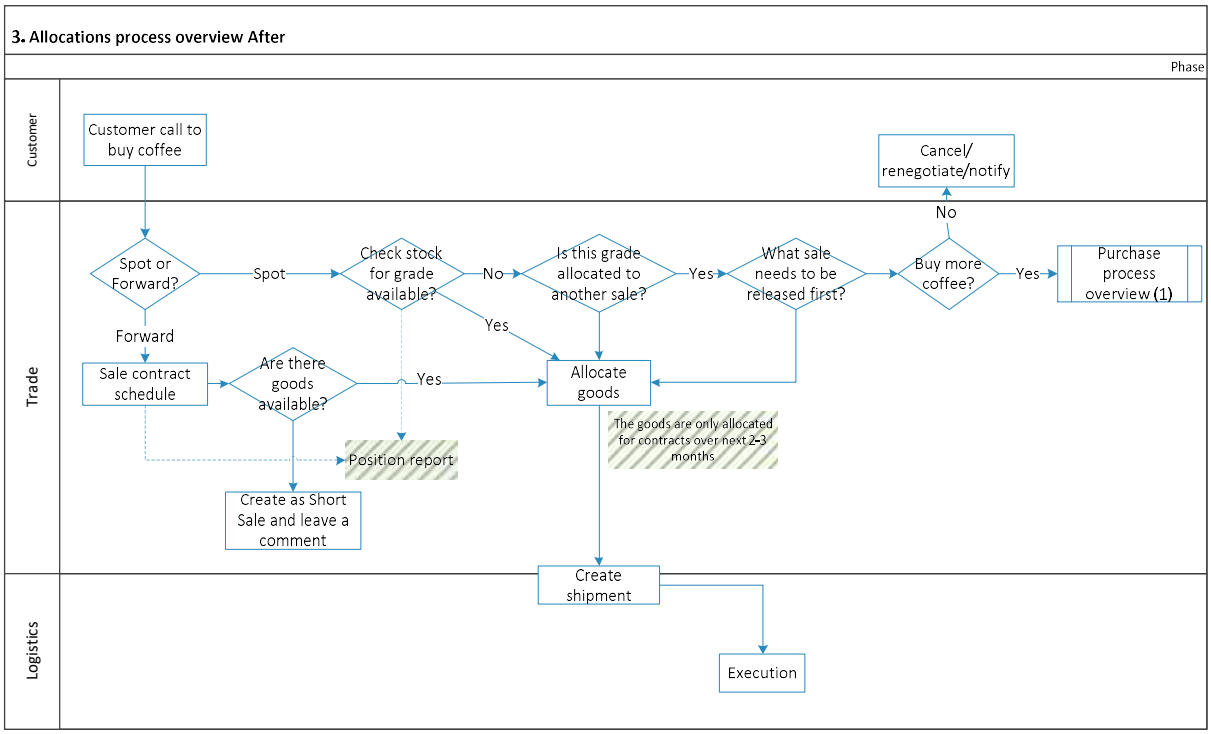
Appendix 14 Spot sale CS2 'After'



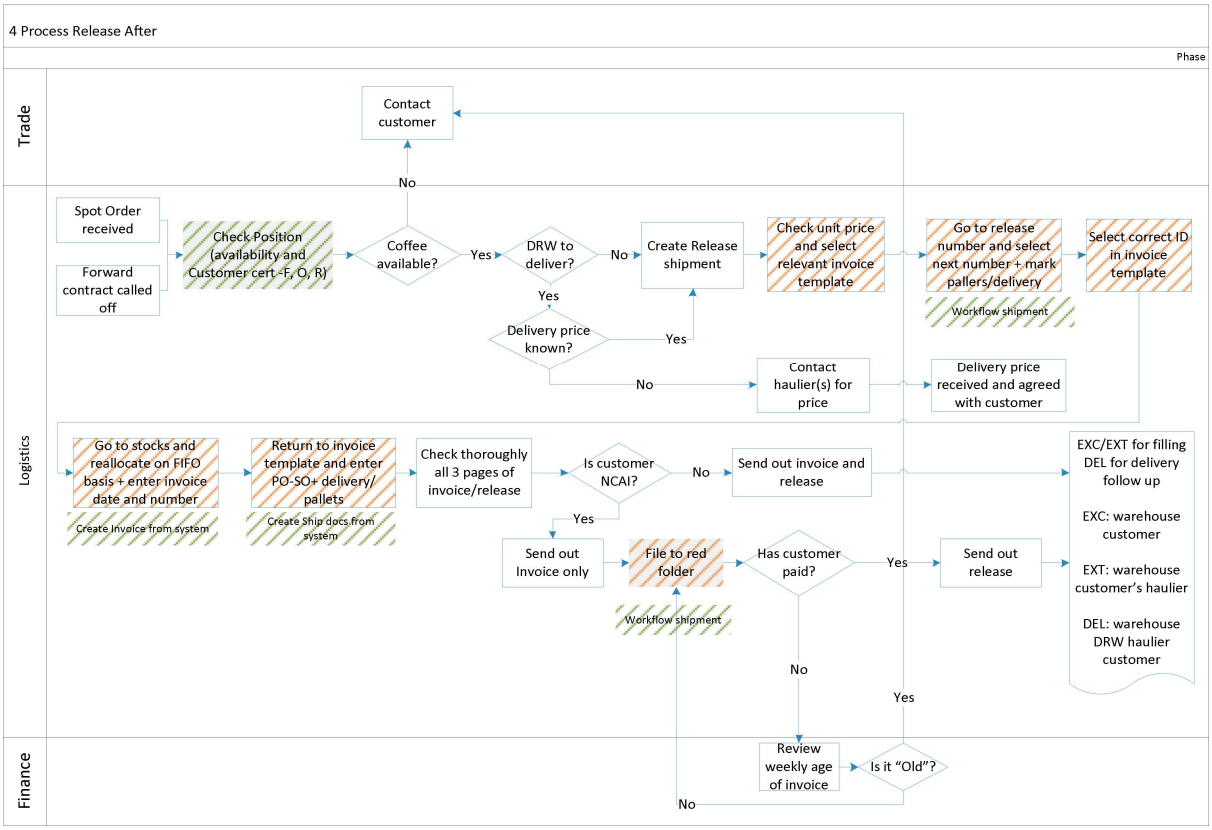
Appendix 15 Fix Purchase price CS2 'After'



Appendix 16 Allocation process overview CS2 'After'



Appendix 17 Process release CS2 'After'



Appendix 18 DSS Physical Position Report

Physical Position

	2010	2011	2012	2013	2014	2015	2016	2017	Total
					Fixed Price				
Purchase	42.00	2.20	15,606.60	104,445.90	52,399.95	81,621.28	259,716.82	86,247.21	600,081.96
Sale	-650.00	-84.00	-210.00	-93,894.82	-50,419.07	-41,837.34	-235,254.63	-141,921.61	-564,271.47
Net	-608.00	-81.80	15,396.60	10,551.08	1,980.88	39,783.94	24,462.19	-55,674.40	35,810.49
					On Call				
Purchase	0.00	0.00	0.00	15.60	1,587.25	140,880.11	6,054.45	20,100.14	168,637.55
Sale	0.00	0.00	0.00	0.00	-8,255.90	-82,449.29	-100.00	-300.00	-91,105.19
Net	0.00	0.00	0.00	15.60	-6,668.65	58,430.82	5,954.45	19,800.14	77,532.36
Total	**-608.00 MT**	**-81.80 MT**	**15,396.60 MT**	**10,566.68 MT**	**-4,687.77 MT**	**98,214.76 MT**	**30,416.64 MT**	**-35,874.26 MT**	**113,342.85 MT**

Toggle Values

Search

Crop Year | Client | Quality | Incoterm | Growth | Payment Terms | Export Restriction | Crop Year/Type | Tag | Schedule

Year	Contract Numbe	Contract Qty	%	Jan	Feb	Mar	Apr	May	Jun	Jul	Au
2010		-26 144	0.0%	0	0	0	0	0	0	0	
2011		-3 517	0.0%	0	95	0	0	0	0	0	
2012		662 054	0.0%	21 715	0	115 885	-9 030	0	0	46 895	15
2013		454 367	0.0%	-4 300	-4 042	7 052	-14 104	14 964	5 195	83 639	23
2014		-200 000 201 551	7.2%	102 390	-104 895	-199 999 887 469	46 173	-28 834	-92 929	3 258	3
2015		-2 499 995 776 517	89.4%	39 407	-2 499 999 760 812	44 812	-246 907	880 380	-119 316	2 200 774	-6
2016		-96 275 692 077	3.4%	164 947	-13 999 860 122	140 506	153 799	164 429	161 307	65 720	-32 49
2017		-1 542 593	0.0%	-1 289 387	-17 181	-213 535	15 586	4 389	692 667	-4 041	-43

Commodity Prices | Currency Prices | File Upload

COMEX Gold	
GCY00 (Cash)	1,250.80
GCJ17 (Apr '17)	1,255.60
GCK17 (May '17)	1,257.10
GCM17 (Jun '17)	1,259.10
GCQ17 (Aug '17)	1,259.10
GCV17 (Oct '17)	1,259.10
GCZ17 (Dec '17)	1,259.10

ICE Cocoa UK	
Jul16 (CCN16)	2,379.00
Sep (CCU16)	2,379.00
Dec16 (CCZ16)	2,379.00
Mar17 (CCH17)	0.00
May17 (CCK17)	0.00
Jul17 (CCN17)	0.00

ICE Cocoa US	
Jul16 (CCN16)	2,986.00
Sep17 (CCU17)	0.00
Sep16 (CCU16)	2,986.00
Dec17 (CCZ17)	0.00
Dec16 (CCZ16)	2,986.00
Mar17 (CCK17)	0.00
May17 (CCK17)	0.00
Jul17 (CCN17)	0.00

ICE Coffee "C"	
Jul16 (KCN16)	115.00
Sep16 (KCU16)	120.00
Dec16 (KCZ16)	170.10
Mar17 (KCH17)	173.80
May17 (KCK17)	138.00
Jul17 (KCN17)	140.45
Sep17 (KCU17)	142.65
Dec17 (KCZ17)	146.10
Mar18 (KCH18)	149.50

ICE Cotton No. 2	
Jul17 (CTN17)	73.31
Oct17(CTV17)	69.06
Dec17 (CTZ17)	69.00
Mar18 (CTH18)	68.43
May18 (CTK18)	68.68
Jul18 (CTN18)	69.04
Dec18 (CTZ18)	67.79
Mar19 (CTH19)	68.60

ICE Sugar No. 11	
Oct14 (SBV14)	15.75
Mar15 (SBH15)	16.88
May15 (SBK15)	17.04
Jul15 (SBN15)	17.23
Oct15 (SBV15)	17.60

LIFFE Feed Wheat	
LWX13	161.10

LIFFE Cocoa	
Dec14 (CZ14)	2,078.33
Mar15 (CH15)	2,071.50
May15 (CK15)	2,068.60
Jul15 (CN15)	2,069.50
Sep15 (CU15)	2,070.00
Dec15 (CZ15)	2,078.54

Appendix 19 Risk Management and M2M

Customer Limits Visualisation

Mark-to-Market report (M2M)

Country		Total					Oct-2017		
	Premium/Discount	Open Qty	Physical P&L	Futures P&L	Open Value	Default	Basis	Price/Adjust	Market Price
Total		**710.8 MT**	**($6,068,492)**	**$33,938**	**($6,075,848)**				
+ BRAZIL		233.3 MT	($596,650)	($7,388)	($608,186)	4	Dec17 (KCZ1	c/lb	150.1000 c/lb
+ COLOMBIA		147.0 MT	($5,369,138)	$41,325	($5,367,471)	1	Dec17 (KCZ1	c/lb	147.1000 c/lb
+ ETHIOPIA		(38.0) MT	$218,943	$0	$221,457	3	Dec17 (KCZ1	c/lb	149.1000 c/lb

Appendix 20 Ethical Approval email

Ilkina, Vera

From: Roberts, Jillian
Sent: 10 July 2015 12:51
To: Lyons, Andrew; Ilkina, Vera
Cc: Drummond, Helga
Subject: Ethics Application - Vera Ilkina - REF 2015.11
Attachments: Reviewers Checklist2-07.07.15.doc; Reviewers Checklist-07.07.15.doc

Follow Up Flag: Follow up
Flag Status: Flagged

Dear Andy and Vera

I am pleased to inform you that the ULMS Ethics Committee has approved your application for ethical approval for your study. However you may like to note the comments made by the reviewers on the attached application.

Details and conditions of the approval can be found below:

Ethics Committee Reference Number:	2015.11
Committee Name:	ULMS Ethics Committee
Title of Study:	*Decision Support Systems for Global Physical Commodity Trading'*
Principal Investigator:	Andy Lyons
Student Investigator:	Vera Ilkina
School/Institute:	Management School
First Reviewer:	Gary Cook
Second Reviewer:	Gary Brown
Approval Date:	10 July 2015

The application was APPROVED subject to the following conditions:

- The researchers must obtain ethical approval from a local research ethics committee if this is an international study
- University of Liverpool approval is subject to compliance with all relevant national legislative requirements if this this is an international study.
- All serious adverse events must be reported to the Sub-Committee within 24 hours of their occurrence, via the Research Integrity and Governance Officer (ethics@liv.ac.uk)
- If it is proposed to make an amendment to the research, you should notify the Committee of the amendment.

This approval applies to the duration of the research. If it is proposed to extend the duration of the study as specified in the application form, the Committee should be notified.

If the named Principal Investigator/Supervisor leaves the employment of the University during the course of this approval, the approval will lapse. Therefore please contact the Committee in order to notify them of a change in Principal Investigator/Supervisor.

Kind regards

Professor Helga Drummond
Chair of ULMS Ethics Committee
University of Liverpool Management School